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The Federal Soil Erosion Projects[1]

By C. E. Ramser[2]

WIDESPREAD public interest in soil erosion and moisture conservation led to the introduction on the floor of the House of Representatives the following paragraph in the 1930 appropriation bill for the Department of Agriculture:

> "Soil Erosion Investigations: To enable the Secretary of Agriculture to make investigation, not otherwise provided for, of the causes of soil erosion and the possibilities of increasing the absorption of rainfall by the soil in the United States, and to devise means to be employed in the preservation of soil, the prevention or control of destructive erosion and the conservation of rainfall by terracing or other means, independently or in cooperation with other branches of the government, state agencies, counties, farm organizations, associations of business men, individuals, $160,000; of which amount $40,000 shall be immediately available."

The director of scientific work appointed a committee to formulate plans and recommendations for carrying out these provisions. This committee consists of the following members: A. G. McCall, chairman, chief of soils, Bureau of Soils and Chemistry; S. H. McCrory, chief, division of agricultural engineering, Bureau of Public Roads; E. H. Clapp, assistant forester, in charge of research branch of the Forest Service; J. G. Lipman, director, New Jersey Agricultural Experiment Station; and A. B. Conner, director, Texas Agricultural Experiment Station.

This committee met on March 12, 1929, and formulated the following general provisional program:

1. A continuation of the erosion reconnoissance survey of the United States and the preparation of a map showing the extent and distribution of eroded areas

2. A survey of the methods now used to control erosion and to conserve soil moisture

3. Laboratory studies of the physical and chemical properties of different soil types in relation to erosion

4. Field and laboratory studies of terraces, soil-saving dams, underdrains and cultural methods to determine the most effective methods for preventing and controlling erosion and conserving soil moisture

5. Field and laboratory studies of the effects of forest cover, chaparral-brush and range cover upon run-off, erosion and stream-flow regulation and of remedial measures through forest management, fire control and range management.

Soil erosion experimental stations will be located in the principal erosion regions in the United States. As a result of the preliminary reconnoissance survey already made, eighteen principal regions have been outlined, in which erosion stations should be established. The areas outlined are shown in Fig. 1.

The first station established is located in the red land regions of Oklahoma and Texas, near Guthrie, Oklahoma (indicated on the map as "13"). Work has been in progress here since about the middle of January and is conducted in cooperation with the Guthrie Chamber of Commerce.

The second station is located near Temple, Texas, in the black lands region of Central Texas (indicated in the map as "12"). Work has been in progress at this station since about the middle of April and is in cooperation with the Texas Agricultural Experiment Station.

The location for a third station has been chosen on the Kansas state agricultural experiment farm, near Hays, in the dark prairie lands of west central Kansas (indicated on the map as "14"). A survey of the farm has been made.

Field examinations have been made for the purpose of locating stations in the gray lands of northern Missouri and southern Iowa (indicated on the map as "9") and in the light colored sandy lands of southwest Arkansas,

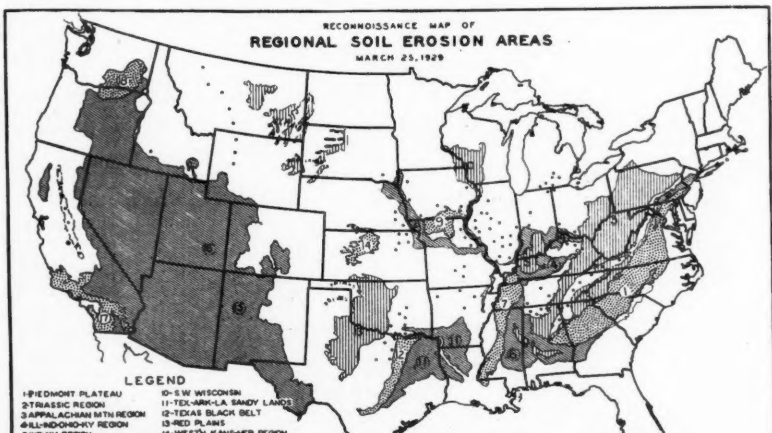

Fig. 1. This reconnoissance map shows, in the shaded portions, the principal erosion areas of the United States. The figures, 1 to 18, indicate where the soil erosion experimental stations of the federal government will be established. Three of these stations have already been definitely located, and at two of them, Guthrie, Okla., (13), and Temple, Tex., (12), the experimental work is now in progress

[1]Paper presented at the 23rd annual meeting of the American Society of Agricultural Engineers, at Dallas, Texas, June, 1929.

[2]Senior drainage engineer, U. S. Department of Agriculture. Mem. A.S.A.E.

northeastern Louisiana and east central Texas (indicated on the map as "11").

Other stations will be located in the near future in the southern Piedmont lands of Virginia, North Carolina, South Carolina and Georgia (indicated on the map as "1"), and in the northern Piedmont lands of New Jersey and Pennsylvania (indicated on the map as "2").

The investigations will be conducted cooperatively for the federal government by the Bureau of Public Roads, the Bureau of Soils and Chemistry, and the Forest Service, all of the Department of Agriculture. The Bureau of Public Roads will be concerned primarily with the engineering phases of the study which will consist principally of investigations on different land slopes and soils to determine:

1. The rates of run-off and amounts of erosion from terraced and unterraced land
2. The effect of vertical and horizontal interval between terraces upon the run-off and rate of erosion
3. The effect of the grade of terraces upon the rate of soil erosion
4. The maximum permissible length of terraces with uniform or variable grade on different slopes and soils
5. Means of preventing erosion at the ends of terraces
6. The effectiveness of terraces in conserving moisture in areas of limited rainfall
7. The effect of terraces on farm operations and upon modern farm machinery when used parallel to and across terraces
8. The most efficient and economical terrace for each principal soil type
9. The conditions under which various types of soil-saving dams built of different materials are most effective, and the factors which should govern the selection of the various types and materials
10. The most economical methods of constructing terraces and soil-saving dams with different types of equipment, more effective methods of construction and more efficient equipment
11. The most effective method of maintaining terraces and soil-saving dams and other devices for preventing soil erosion
12. The effect of cultural operations upon erosion and the possibility of preventing erosion by improved methods
13. The effect of various cover crops in reducing or preventing erosion when these are used in conjunction with terraces or other preventive works.

The Division of Agricultural Engineering of the Bureau of Public Roads has been carrying on investigations and experiments on soil erosion and terracing since May, 1924, at Raleigh, N. C., in cooperation with the North Carolina Agricultural Experiment Station and had arranged for the establishment of a soil erosion experimental farm near Guthrie, Oklahoma, prior to the enactment of the bill by Congress carrying this special appropriation for soil-erosion investigations. This accounts for the fact that the work at Guthrie was begun prior to the passage of the appropriation bill.

The experimental farm about four miles south of Guthrie, Okla., contains 160 acres. Work was started on this farm about January 15, 1929. Since that time about 15 acres of land have been cleared and partly grubbed; 1800 feet of gullies have been filled with brush; 75 acres of land have been terraced on which 7 miles of terraces have been constructed; and 45 brush dams, 8 rock dams, 4 woven wire dams and 6 pole dams have been built for checking erosion in gullies. The cropping plan is as follows: 60 acres of cotton, 8 acres of soybeans, 18 acres of cowpeas, 5 acres of sweet clover, 2 acres of mung beans, 2½ acres of Sudan grass and 5½ acres of cane.

Five sets of terracing experiments have been laid out. One set consists of six terraces 700 feet in length with a uniform fall of 4 inches in 100 feet and vertical intervals between terraces of 2, 3½, and 5 feet. The slope of the land varies from about 5 to 7 per cent. Venturi flumes (Fig. 2) for measuring the runoff have been installed at the ends of these terraces and silt-measuring devices will be placed at these flumes. A continuous record of water stage in the flumes is obtained with Bristol float recorders specially designed to record the time to the nearest minute and the stage to the nearest 0.01 foot. From this continuous record it will be possible to determine the time of concentration for the terrace. Two self-recording rain gages located on the farm will furnish data on the intensities and duration of rains for short periods. The results of these experiments will afford information on the proper vertical interval for terraces for the particular soil and slope, and on the design of the terrace channel.

A view of this field is shown in Fig. 3 before terracing work was started. This field had been used as pasture and had never been plowed. It was covered with a growth of small scrub oak trees and sprouts, and there were many old live stumps in the ground and a considerable outcropping of rock on the upper part of the field. This field was cleared and most of the stumps were grubbed out. In all, ten terraces were built. Outcropping rocks and numerous stumps and roots made construction of the

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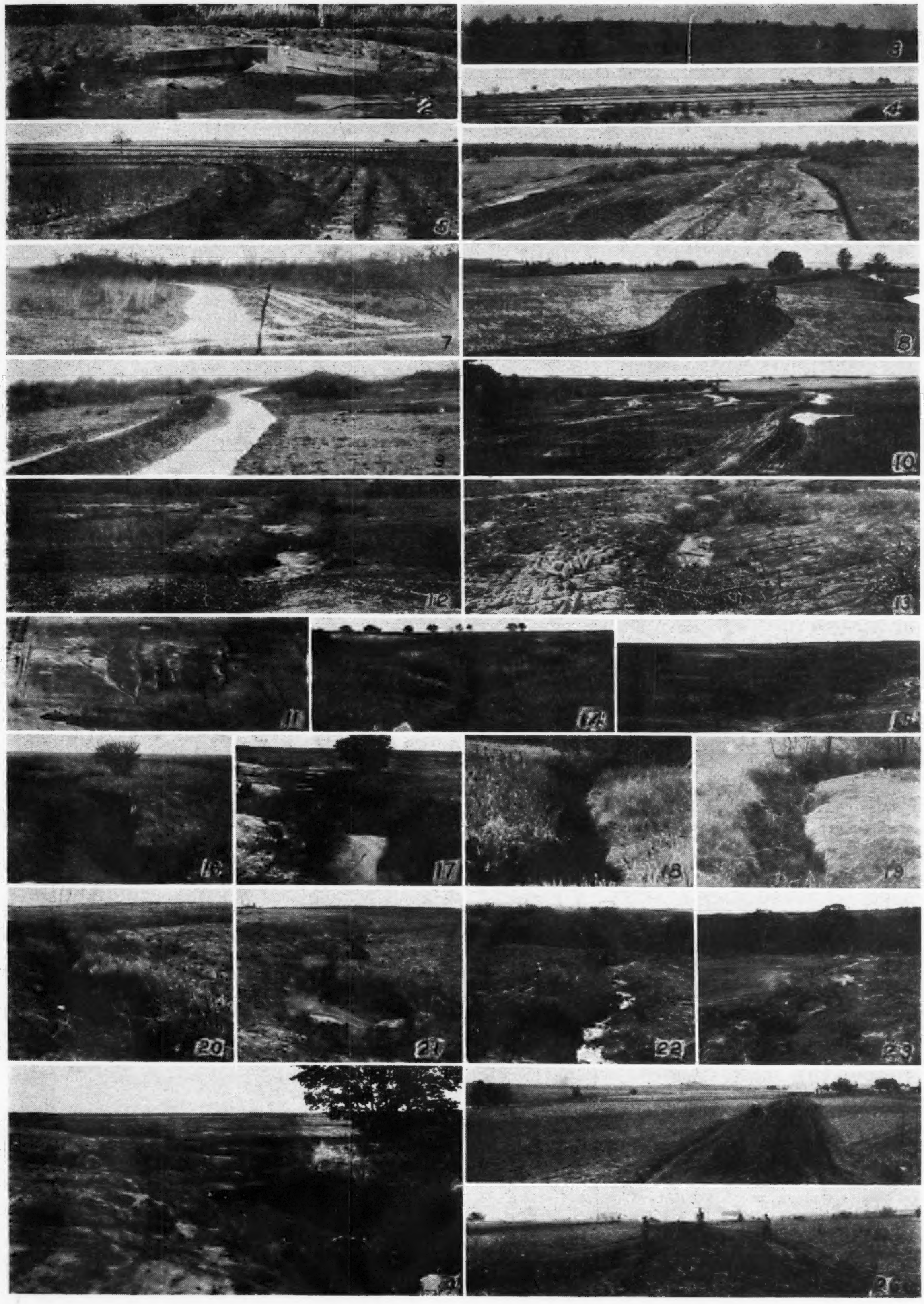
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terraces exceedingly difficult. A heavy road plow and a large Martin ditcher were used for this work. The terraces were built with a base width of 20 feet and a height of from 18 to 24 inches. Rows will be run parallel to these terraces the first year and then across the terraces. The base width of the terraces will be increased if necessary in order to operate machinery across them. Fig. 4 shows the field after terraces were constructed.

The second set of terracing experiments consists of four terraces 1,500 feet in length and with grades as follows: Level, 2 inches, 4 inches, and 6 inches per hundred feet. Measurements of soil losses and rate of runoff from these terraces will be made. The results will afford information on the proper grade to be used in laying out terraces for the particular soil and slopes, as indicated by the soil losses and runoff, and on the effect of the grade of a terrace on the conservation of moisture.

In Fig. 5 is shown a view of this field, part of which was planted to cotton last year, and part of which is virgin prairie. These terraces were built with an 8-foot Corsicana ditcher. The base width was made 25 feet and the height about 16 inches. The lower terrace in the view is under construction, one round having been made with the Corsicana ditcher.

The third set of experiments consists of five terraces about one-half mile long, two located on virgin land and three on eroded and gullied land. The grades of the two terraces on virgin land and two of those on eroded land are variable. For one terrace the grade varies from level to 4 inches in 100 feet, and for another from level to 6 inches on each kind of land. The fifth terrace has a uniform fall of 3 inches per 100 feet. Runoff and soil losses from these terraces will be measured which will furnish information on the length that terraces can be built without erosion on virgin and eroded soil and on the proper grade and vertical interval for long terraces.

The upper end of the terraces on virgin soil extend through land which was cleared just prior to the construction of the terraces. In Fig. 6 is shown a view of one of these terraces. This terrace has a base width of 30 feet and a height of about 18 inches. Two of the terraces located on the eroded land are 2,875 feet long, one having a base width of 25 feet and the other 30 feet. Fig. 7 is a view of one of these long terraces showing the water flowing off in the broad terrace channel after a heavy rain.

The fourth set of experiments consists of three level terraces mostly on virgin soil and on a land slope of about 2½ feet per 100 feet, two of which encircle the top of a knoll near the center of the farm and the other ends closed so that all of the rainfall is caught and held above these terraces until it evaporates or percolates into the soil. From these experiments information on the proper spacing of level terraces will be obtained, the effect upon crop yields of conserving all the rainfall and the extent of injury to crops due to the water standing above the terraces. In Fig. 8 is shown a view of one of the terraces being built with a Corsicana ditcher in prairie sod.

Fig. 9 is a view of one of these level terraces showing the water which has accumulated above the terrace during a heavy rain. With such a terrace no water or any of the fertile soil particles escape from the field. If it is found that undue injury to crops results from impounding the water, a system of tile drainage will be installed, or simply a tile outlet to remove the impounded water. This terrace was built with a plow and a wooden road drag and has a base width of 20 feet and a height of about 18 inches.

The fifth set of experiments consists of ten level terraces varying in length from 200 to 700 feet and with vertical interval varying from 2 to 4 feet. The average slope of the field is about 4½ feet per 100 feet. Part of this same field is left unterraced. One end of the level terraces is closed and a small embankment is built 100 feet from the end so that all of the rainfall that falls on this 100-foot length is caught and held. These experiments will afford information on the length and spacing of level terraces on eroded land for the particular soil and land slope, and on the effect upon crop yields of conserving all of the rainfall by means of the level terrace with closed ends, and part of the rainfall by the level terraces with one end left open and of conserving none of the rainfall on the land that is left unterraced. In Fig. 10 is shown the lower terraces of this field which were built across gullies 4 to 5 feet deep. Note the water caught above terraces at crossings of gullies.

The lower part of this field is badly gullied so that considerable work with a team and slip scraper was required in order to build up the terraces to the required height. The terraces have a base width of 20 feet and a height of about 18 inches and were built with a Corsicana ditcher. The height of terraces where all of the water is impounded will be increased if it is found necessary. In this way the required height of level terraces for different vertical intervals will be determined.

In addition to the information to be obtained in the foregoing experiments much data has been collected on the time required in the construction of terraces of different dimensions with different kinds of terracing implements. Comparison will be afforded on the practicability of crossing terraces or running the rows parallel to terraces having base widths varying from 20 to 30 feet and heights varying from 1 to 2 feet.

A series of plots has been laid out on a badly eroded and gullied slope which has been left unterraced (Fig. 11), erosion being checked in the gullies by means of brush, rock and pole dams. The plots are planted to various cover crops which will be plowed under to build up the fertility of the soil. These plots have been planted to sweet clover, cowpeas, Sudan grass, sumac cane, soybeans, and mung beans. These plots will be planted to cotton in alternate years, and check plots will be planted to cotton every year so that a comparison can be made of the cotton yields on the cover crop plots and cotton check plot, thus affording information on the relative value of the various cover crops as soil builders, and on the rapidity with which the soil is built up by comparing the yields on the cover crop plots with those from the plots planted to cotton every year.

In building the soil-saving and check dams in the gullies, different materials consisting of rock, brush, poles and old woven wire, all of which were available on the farm, were used. Different methods of construction were employed. The dams were built of different heights and widths and the spacing between the dams was varied. Data on the cost of constructing the dams was kept. Observation of the manner in which these dams function will afford information on the best methods to be employed in their construction.

Rock was found on the bottoms of most of the gullies so that it was impossible in most cases to anchor dams by driving stakes into the bottom of the gullies. In building brush dams where rock was encountered the dams were anchored by means of poles, the large ends of each pole being set in the ground near the bottom of the side of the gully, bent over the brush and fastened to a stake on the top of the bank. The brush was laid with the butts upstream. The poles cross at the center of the gully and thus form a low place for the water to flow over without eroding the sides of the gully. Fig. 12 shows a pole and brush dam under construction near the lower end of the gully and in the upper part of the gully there are two completed dams. These dams are usually built 10 to 15 feet lengthwise of the gully and three or four sets of poles are used to anchor them down. In Fig. 13 is shown silt caught above pole and brush dams due to one rain of about 1½ inches. Figs. 14 and 15 show views of a gully and its branches taken before and after the construction of brush dams anchored with poles. Note the silt caught above the dams due to a few rains.

A number of loose brush dams, some weighted down

with rock, were built. In Figs. 16 and 17 are shown views of a gully before and after the construction of loose brush dams. Most of the silt above these dams was caught during one heavy rain of about 2½ inches. One loose brush dam in this gully was floated down to the next dam below which was fastened. It was found that not much dependence can be placed on loose brush dams where there is considerable flow in a gully. The greater the flow the more securely should brush dams be anchored.

In Figs. 18 and 19 are shown views of a gully before and after being partially filled with brush. The brush was carefully placed in the gully with tops upstream in the manner in which a house is shingled and was weighted down with rock. The brush in this gully which varied from about 3 to 8 feet deep caught silt nearly to the top of the brush in the upper end of the gully as a result of about four rains. Where plenty of brush is available this is a quick and effective method of reclaiming a gully.

In Figs. 20 and 21 are shown views of a gully before and after the construction of check dams built with small poles laid across the gully and fastened together with spikes. Poles extending lengthwise of the gully from an apron below prevent washing and undermining the dams, and the notch in the center permits the water to pass through without eroding the sides of the gully. As the dams were built the poles were laid in grass or straw, and after completion earth was placed and tamped above the dams to prevent possible flow through the dams. Where earth was not placed above for experimental purposes considerable washing occurred around the ends of the dams. There are six dams in this gully and they are 1, 1½ and 2 feet high and spaced so that the crest of one dam is at the level of the foot of the dam above. These dams which are nonporous have been very effective. Most of the silt which is up to the level of the crest of these dams was caught during one heavy rain of about 1¼ inches. In Figs. 22 and 23 are views of the gully from the upper end taken before and after the construction of the pole dams. This was taken after several heavy rains occurred and the dams were filled to their capacity with silt.

In Fig. 24 is shown a loose rock dam built at the head of a gully. The rock in this dam was carefully placed and the spaces between the rock filled with dead grass to prevent water flowing through. The center of the dam was built lower than the sides to prevent washing around the ends. This dam is 2 feet high and caught silt to the level of its crest during two rains.

The results of these experiments show that rock, brush and poles can be used successfully in building dams in gullies with moderate flow. The greater the flow, the more securely must the dams be anchored. A number of woven wire and large brush dams firmly anchored to stakes with wire were built in a large ravine which has a drainage area of 20 to 30 acres and have withstood the effects of several heavy rains. It is also planned to experiment in the construction of concrete dams and earth soil-saving dams

Approximately 40 tons of soil per acre were washed out of this field by a single rainy period in the fall of 1927. With this soil went also much of the seedling grain

with pipe outlets, concrete spillways, and with metal dams of various descriptions.

The experimental farm located about 3 miles south of Temple, Texas, contains about 140 acres. It is situated about one mile from the Texas Black Land Agricultural Experiment Station. About ninety acres of this farm is in oats and the remainder has been planted to corn and cotton. A field of about 15 acres was planted to cotton after terracing. Eight level terraces were constructed in this field. In Fig. 25 is shown a view of one of these terraces being built with a tractor and 8-foot Corsicana ditcher. These terraces were built with base widths of 20, 25 and 30 feet. The cotton rows are run parallel to one of the longer terraces near the center of the field and across the other terraces from which information on the effect of crossing terraces of different base widths will be obtained. The vertical distances between the terraces were made 4, 3 and 2 feet, beginning with a 4-foot spacing between the upper two terraces at the top of the slope. The upper three terraces were built 15 inches, the next three 18 inches and the lower two 15 inches in height. These variations in height and width will afford information on the proper height and spacing for level terraces. There is also a considerable difference in the lengths of the terraces which should afford information as to effect of length upon the flow from level terraces with ends open. In Fig. 26 is shown one of the upper terraces with 30-foot base width and height of about 15 inches.

At one edge of the field a strip 100 feet wide is left unterraced. Next to this strip the ends of the terraces are closed and at a distance of 100 feet from the ends. Embankments of earth are constructed so as to hold all the water that falls between the terraces. The other end of the terraces is left open. From this arrangement a comparison can be made of the effect of moisture upon the crop yield obtained from the unterraced land, the land where all of the water is held above the terraces and the land where the ends of the terraces are left open. Also a comparison can be made of evidences of erosion between the unterraced and the terraced land. Recent heavy rains here indicated clearly the great benefit to land derived from terracing by comparing the effects of erosion on the unterraced area with the terraced area where no appreciable washing occurred between terraces with ends open.

Since these terraces were constructed a rain of 7.77 inches falling in about 24 hours has occurred. All of the level terraces with closed ends were overtopped, which indicates that it is not possible to impound all of the water from such a rain unless the terraces are built abnormally high. The terraces with open ends withstood the rain successfully. These terraces have their outlet end in a highway ditch and can be seen from this highway. After this heavy rain the following statement appeared in the local newspaper: "Experimental terracing work south of here on the K T highway near the experiment farm stood a good test in the heavy rains and a glance from the highway will satisfy anyone as to the value of terracing."

It is intended to continue the experimental work on the various farms over a period not to exceed ten years, during which time a great variety of experiments relating to soil erosion and moisture conservation will be conducted In order to arrive at the most desirable values for the various factors entering into the proper design of terraces and soil-saving devices, an endeavor will be made to cover a wide range in values which, of course, will result in the employment of some values for these factors that ultimately would not be recommended for general practice.

The field for experimentation in controlling soil erosion is certainly extensive owing to the many factors and therefore possible combinations of factors that require detailed consideration in a comprehensive investigation of the subject. Suggestions for experimental work that will assist in clarifying some of the many problems involved in a complete soil erosion study will indeed be welcomed and greatly appreciated.

Roadside and Hillside Protection Against Soil Erosion[1]

By W. H. McPheeters[2]

EIGHT years ago in Oklahoma terracing was so new that it was hard to find fields here and there on which to hold terracing demonstrations, but today the value of terracing is fairly well understood by farmers at large. I had been in the field but about two years when I saw another big problem loom up as a result of terracing, but did not think it advisable to call much attention to at that time, for fear that it would interfere with the acceptance of terracing by the people. If I had got out in public talks, and at demonstrations, and told the people how much trouble it would be to take care of the terrace water, I am sure it would have been a hard problem to have sold terracing as it has been sold in Oklahoma in the past eight years.

Now since terracing is sold, our next big problem is to sell the idea of taking care of the terrace water, before the cost becomes prohibitive.

As far as Oklahoma is concerned, the taking care of terrace water properly is new. We have advocated putting the terrace water into a ditch along a fence line, or into pastures or into the road ditch but these ditches become very large in a few years. As more and more people begin to terrace, which they are and will, the problem of road ditch protection is going to force something to be done. In Oklahoma today there are some county commissioners who are objecting to terrace water being emptied into the road ditch, and since so many fields have no other satisfactory outlet there will have to be some agreement between farmer and county official, in order to take care of terrace water. The terracing program must continue or the greater portion of Oklahoma soil will have to be abandoned, as far as farming is concerned.

As I see it, a lot of work must be done to find out the best and the cheapest method of protecting the ditches that are to carry the water from the terrace. This is a problem for the American Society of Agricultural Engineers. I have been working on it for about two years and expect to continue. So far it seems that the best method is to carry the water down the ditch over a series of nearly level benches or steps, each step being held by a baffle. During the past few years I have found out through observation and experience a few things necessary in baffle construction which I shall endeavor to explain.

There are many fields that have quite a number of large ditches in them. I shall assume it has been decided to terrace one of these fields. After it is terraced most of the water from the entire field will be emptied into the ditch line along a fence or into the road ditch. It shouldn't take much imagination to picture what will happen to this one ditch if the same amount of water on about the same slope has made several large ditches in the field.

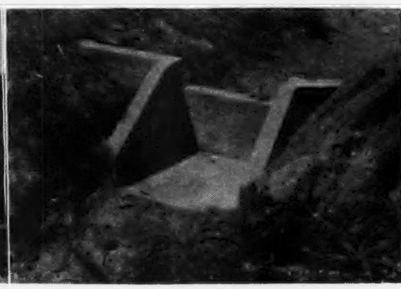
The proper thing to do is to make this ditch like one wants it rather than let the water cut out a gorge at will. This ditch may be made wide and flat to serve as a turn at the end of rows along a fence line, or it may be made narrow and deep. It will be both cheaper and easier to control the water in the broad flat ditch for the drop over the baffle will be a very short distance while if the ditch is deep it will of necessity mean the water must fall several feet. This means a more expensive baffle to construct and also to maintain.

For the construction of a series of baffles, along a fence line where the terrace water is to be carried, a flat ditch 10 feet wide and about 10 inches deep should be made, then cross ditches, where baffles are to be constructed, dig the desired depth and wide enough to include the baffle and the apron. The soil on the upper side of the ditch serves as a form for the upper side of the baffle and consequently only one side of the baffle need be formed with lumber. This form lacks 4 or 5 inches, the thickness of the apron, of going to the bottom of the ditch, then when the concrete is poured it will run under forming part of the apron. As soon as the form is filled with concrete, immediately cast the apron. Thus, the cross-section of this baffle will look about like the letter L, all in one piece of concrete as shown in Fig. 2.

The tops of these baffles are level with the bottom of this straight-line ditch but water flowing in the ditch will soon cut the soil out forming a series of steps or benches. The dirt on the lower side of the baffles will be washed away, down as low as the apron. The apron on this baffle should be about the same level as the top of the baffle just below it. The throat or water gap should be deep enough so that when the maximum rains occur the water will not get higher than the ends forming the throat. The ends of the baffle should project 18 inches to 2 feet into the bank. Another precaution must

[1]Paper presented at the 23rd annual meeting of the American Society of Agricultural Engineers, at Dallas, Texas, June, 1929.

[2]Field agricultural engineer, Portland Cement Association. Assoc. Mem. A.S.A.E.



(Left) Fig. 1. This picture shows the series of baffles constructed before any terrace water had been emptied in the ditch line. Consequently, the construction of these baffles was easy and at a comparatively low cost. This picture was taken on Green Acre Farm near Guthrie, Oklahoma. (Center) Fig. 3. A properly constructed concrete baffle for roadside ditches or for ditches along fence lines to carry terrace water. (Right) Fig. 4. This picture shows a baffle with a serious fault of not having an abutment at each end on its lower side, consequently the dirt is washed away and the baffle will soon be free to move down hill

Fig. 7. A concrete drop on the end of a terrace to the road ditch. This drop is about 3½ or 4 feet and was made without the use of any lumber for forms. It is reinforced with heavy hog wire

be taken in case of high baffles, that is, an abutment should be made on the lower side of the baffle at each end to keep water from washing the bank away and letting the baffle be free to move down hill. (Fig. 3.)

Another precaution will be to extend a lip down 8 to 10 inches deep on the outer edge of the apron to keep water from undermining the apron and finally undermining the baffle. I helped construct a series of baffles on the Green Acre Farm near Guthrie (Fig. 2.) as a demonstration and I expect to watch them for the next few years, making minor improvements as necessity demands. About 80 to 100 acres of land drains through this ditch. Only six baffles were constructed but several more will be made as soon as the farmer gets time. This

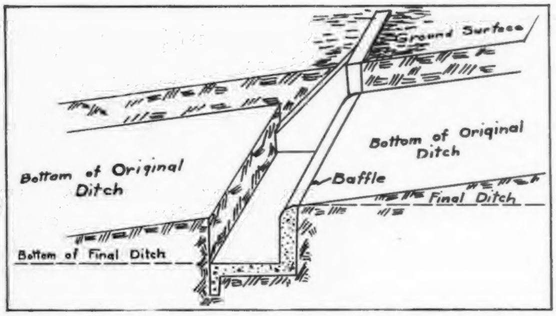


Fig. 2. Sectional view of a newly constructed baffle in a hillside ditch carrying terrace water

ditch is between the barns and farm land. This is the first demonstration of this kind I have held and I believe and hope it will prove satisfactory. I estimate that the total cost of all nine baffles will be less than two baffles would cost if terrace water were allowed to have its way in this ditch for three or four years. This ditch, protected as it is, may be crossed almost any place along it, while if the water were allowed to have its way for a period of three or four years I doubt if it could be crossed at any point by a team.

Fig. 4 shows a baffle of about a three-foot fall. It is well constructed but has a very serious fault. It will be noticed that the bank just below the baffle is almost washed away. This trouble could have been remedied if an abutment had been made as shown in Fig. 3 at each end on the lower side and connected with the apron at the bottom.

These baffles, both for road ditch and field ditch protection, may be made of concrete or of hard rock such as granite, limestone and flint laid in cement mortar. Sand rock is not satisfactory. Fig. 5. In Wagoner County, Oklahoma, a number of baffles 5 or 6 years ago were built of soft sand rock. In this time a number of them have begun to crumble. The labor in putting the baffles in is too large an item of cost to waste by using a soft porous material to build with. These baffles are subjected to the most severe weather conditions. Every rain tends to soak them full of water. If they are porous they will take up this water and freezing weather will cause them to crumble.

I wish to call attention to a few faults that are being made in baffle construction. One is, as stated before, leaving off the abutments below the baffle. The falling water has a churning effect and cuts the dirt away from the ends of the baffle on the lower side. Another fault is that the throat which carries the water is being made,

(Left) Fig. 6. This ditch was about nine or ten feet deep with the road and fence caving in five years ago. Sam Todd, county commissioner. Wagoner County, Okla., built these baffles and has saved the road although he was advised at that time to abandon this road and buy a new right-of-way rather than try to save it. (Right) Fig. 8. A common fault with many baffles of not having sufficient throat or water gap; consequently, the water has washed around the end of the baffle


(Left) Fig. 5. A baffle made of sand rock crumbling at the end of five years due to weathering. (Right) Fig. 9. A series of concrete baffles along a road ditch. They are large but have the fault of having no abutments

in a great many cases, entirely too shallow and in many cases too narrow. Consequently, water washes around the ends of the baffle. Another fault is that the apron has no lip extending down on the outer side and water washes the dirt from under the apron, undermining it. If the baffles are made so that the top of the baffle is on the same level as the top of the apron just above it a thin lip sticking down some six or eight inches will very materially help to prevent undermining of the apron.

Water tends to seep underneath the baffle if sufficient foundation is not put in to overcome this. It is advisable to put several scrapers of dirt in the bottom of the ditch on the upper side of the baffle and tamp it in a little. This gives it a chance to hold until this portion becomes filled with soil.

A good precaution in high baffles is to put a weep hole somewhere below the middle of the baffle. This allows water to drain out rather than to stand above the baffle until it finally soaks away. Another thing worth mentioning in road ditch baffles is to put the throat that carries the water a little nearer the side of the ditch away from the road. Sam Todd, county commissioner, Wagoner County (Okla.), through five years of experience found this to be worth considering. He says it is easier to keep the road in good condition with the water gap farther from the road than when it is in the center of the ditch. Baffles can best be built before the ditches is made large by the water because it takes less material and less labor. After a ditch is made large it must gradually be filled by soil settling out of the water. Of course, there are many ditches today along roads and fence lines that are already large but in this case the quicker baffles are built, the better. It is easier to make the ditch like you want it from the start than to try to make it like you want it after it is large.

Mr. Todd, referred to above, was advised six years ago to abandon a piece of road and get a new right-of-way. On one side the ditch was ten feet deep and caved in in places. He built concrete baffles from the bottom of the ditch up to where he wanted the bottom of the road ditch. In five years he has this filled up and grass growing in it until you could never know it had been there. All that is showing is the ends of the concrete baffle forming the throat. The throats are large enough to carry the water. Though it was a little expensive building these high baffles it was by far cheaper than buying a new right-of-way and building a new road. Besides, the road is where it ought to be. Fig. 6).

The baffles I have talked about so far are baffles to be placed in a ditch that is to continue carrying water regularly for a long period of time. If there happens to be a ditch in a field that is large and the field is to be terraced but the ditch is too large to cross, it would not be necessary to build a permanent baffle. Any temporary dam that will hold the soil for a few years until the gully is partially filled and terraces can be made across it will eliminate this ditch as a permanent water carrier. The water will be carried by the terraces and emptied into a permanent ditch which should be protected with permanent concrete baffles.

There is one other phase of this work that is of importance to the farmer. Where water has to fall several feet from the field to the road ditch, it will cut back several feet per year and finally eat a large gully back along the terrace unless something is done to stop it. A concrete drop will prevent this, and should be made before any ditch is formed, in order to cut the cost of construction down as low as possible. This is a phase of work where comparatively little experimental work has been done. A drop may be made with a baffle similar to the ones in the ditch as shown in Fig. 3. Or it might be made by digging a form in the earth as shown in Fig. 7, letting the water go from the field to the road ditch at an angle of probably 45 degrees rather than straight down. This type of drop for a single terrace emptying into the road is going to be very satisfactory because it can be made without form lumber. It can be reinforced easily with hog wire, however, I am not recommending it unconditionally because I have only constructed two or three of them and would like to watch them before I give unqualified recommendations. At present it looks feasible because of ease of construction and low cost. There are many types of drops which I expect to work on for the next year.

Russian Agricultural Engineering Publications

THE Russian Department of Agriculture, or as it is known for short in Russian "Narkomzem," publishes several weekly, and monthly periodicals. Among the latter "Sovkhoz," or "The Soviet Farm" contains considerable information on tractors, and industrialization of the farm.

Narkomzem also publishes a large number of bulletins, and books of practical nature, and some of more scientific character on various phases of agriculture. Several books have been issued on subjects pertaining to agricultural machinery. Among these are: "International Tractor" by L. N. Aginski; "Mowers, Harvesters and Binders," "Implements and Tools for Peasants," and "How to Run a Threshing Machine," all by U. A. Weis; "One Bottom and Multi-Bottom Plows," by B. A. Kril; "Introduction to Agricultural Machinery," by G. I. Kulikov; "Grain Cleaning Machinery" by N. B. Bechin, and "Shops for Repairing Tractors" by S. I. Rolenko (in four volumes).—J. W. Pincus, consulting agriculturist.

Soil Moisture and Fertility Conservation[1]

By R. E. Dickson[2]

"DUTY of water" is a technical term used by engineers to designate the irrigation requirements of various crops on arable lands. When used by laymen it has a broader and more significient meaning and covers a multitiude of problems of forest, grazing and agricultural lands. It has to do with the losses of soil fertility through erosion, and so effects not only the present generation but posterity. It has to do with navigation as many of the streams are being clogged with silt and detritus brought down by flood waters from the upper catchment. It has to do with the impounding of storm waters for city water supplies, tank water for livestock on the range, and impounded water for irrigation purposes. Ample water is one of the most perplexing problems of cities, farms and industries. Much research is needed in order to determine the full duty of the water that reaches the earth's surface in the form of rains and snows. The Texas Agricultural Experiment Station, in order to solve that portion of the problem of the duty of water as applied to the growing of crops, started experimentation at Substation No. 7, at Spur, Texas, in 1926.

Rainfall data which has accrued over a period of seventeen years at the Spur station, furnished a valuable foundation for the research to follow. The total rainfall for a region is a poor yardstick for measuring the agriculture of that section. Only a certain amount of rain is needed to produce maximum crops and when an excess occurs it may lead to erosion, insect infestation, deterioration of crops in the field, extra labor in suppressing weed growth and numerous other costly results.

Seasonal rainfall is much more important than the total rainfall. Localities, and even regions, with annual rainfall of around 40 inches frequently have crops suffer for lack of moisture at a critical period in mid-summer. The accompanying graph is presented to show the seasonal rainfall at Spur and at five other experiment stations that are located in the central and eastern portions of the state. The upper curve represents the annual rainfall over a long period of years at Denton, Temple, Beeville, Troup and College Station, which is 36.64 inches. The lower curve is the rainfall at Spur over 17 years and is 22.007 inches annually.

These five stations have an annual rainfall of 66.5 per cent more than at Spur, but for the four critical months of June, July, August and September, inclusive, the rainfall for the five central and east Texas stations totals 10.80 inches and at Spur 10.30 inches, or the rainfall is 4.8 per cent greater.

The graph also shows a very interesting period in midsummer with deficient rainfall which makes the storing of water from the spring rains for the use of crops at a critical period a very desirable practice. The duty of water in cotton production in central and eastern Texas is probably more serious than it is in western Texas, due to the fact that July, a time of deficient rainfall, is also the period of heavy fruiting in the eastern portion of the state while the fruiting in the western portion occurs a month later under much more favorable conditions. The planting date of cotton in the eastern portion of the state can not be shoved forward due to the ravages of the boll weevil that generally appears in destructive numbers in August. It is very evident that the storage of water in the soil for plant use in midsummer can be practiced to advantage throughout the state.

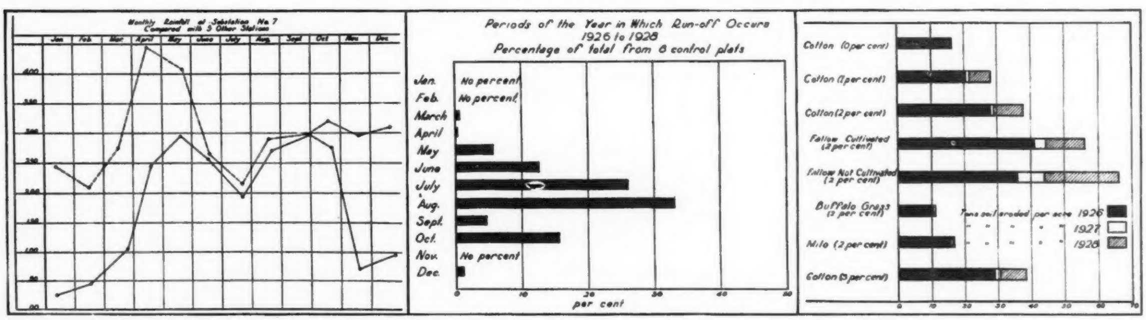
The equipment for the study of water and soil losses at the Spur station consists of meteorological instruments for studying the factors influencing evaporation, transpiration, percolation and runoff; a battery of well-equipped control plats one-seventy-fifth of an acre in size for the studying of the influence of the slope of land, crops and tillage on water and soil losses. There are ten field areas totaling 100 acres that are equipped with water-stage recorders, still ponds and weirs for the studying of the effect of terraces, dikes, contoured rows and other obstructions on water losses through runoff.

A full discussion of the forty-two tentative conclusions from the three-year's work would not be possible here. However, a few of the more important findings may be mentioned briefly and those interested in seeing a full report of the work can secure a bulletin that is being published by writing the Director of Experiment Stations, College Station, Texas.

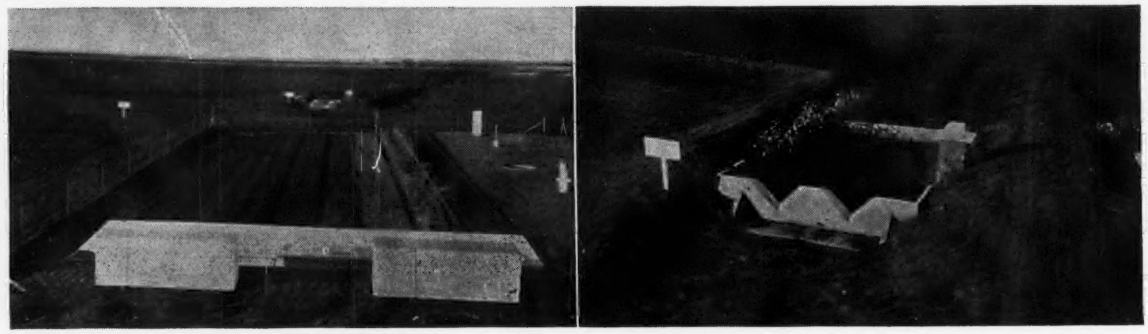
Rains may be classified as effective and ineffective. Effective rains may be defined as those that are stored in the soil and are subsequently used for plant development.

[1]Paper presented at the 23rd annual meeting of the American Society of Agricultural Engineers, at Dallas, Texas, June, 1929.

[2]Superintendent, Substation No. 7, Texas Agricultural Experiment Station.



(Left) The total rainfall is a poor yardstick for measuring the agriculture of a section. The above graph shows the distribution of the 22 inches annual rainfall at Spur (Texas) as compard with the distribution of the 36 inches annual rainfall in the older cotton-producing sections. The rainfall during the four growing months of June to September is practically identical. The torrential April and May rains in the older section are usually very destructive through erosion and set up many complications in farm management. (Center) Records are available as to the amount of water lost as runoff during the past three years. The greatest amount of runoff occurs during July and August, which is the period of the year that crops are most likely to suffer from a shortage of moisture. (Right) This graph shows the tons of soil eroded per acre from eight control plats one-seventy-fifth of an acre in size. Greater losses occurred with torrential rains in 1926. The rainfall for 1927 and 1928 was below normal



(Left) Eight control plats one-seventy-fifth of an acre in size, bordered with galvanized iron. In the foreground are soil boxes that contain the eroded soil from the plats. At the near end of the plats, under the cover, are concrete vats six by eight feet and four feet deep that are used for catching the water and soil that is lost from the plats. From left to right these plats have the following crops and treatment: (1) Level grade planted to cotton, (2) one per cent grade planted to cotton, (3) two per cent grade planted to cotton, (4) two per cent grade fallowed and cultivated, (5) two per cent grade fallowed and not cultivated, (6) two per cent grade sodded to grass, (7) two per cent grade planted to milo, and (8) three per cent grade planted to cotton. (Right) There are six of these weirs with water stage recorders set on six field areas and used for measuring the water runoff from field areas of approximately 10 acres that are terraced in different ways

Ineffective rains are those that have no value in so far as plant growth is concerned. Rains may be made ineffective by occurring as small isolated showers that are lost through evaporation shortly after falling; other rains are rendered largely ineffective through runoff. They are also destructive. Still other rains occur in off-seasons for the crop that is to be grown on the land and the moisture that is stored in the soil is lost through evaporation, percolation or transpiration in weed growth before the crop has an opportunity to use it.

The accompanying table is given as an indication of some of the ways in which water is lost and of the possible amount that has been available for plant use during the three years of the test:

Data on Rainfall Lost and Available for Plant Use

Year	Rainfall, inches	Ineffective small showers, inches	Lost as runoff from two per cent grade planted to cotton, inches	Available for plant use**
*1926	27.99	2.50	7.13	18.36
1927	16.12	6.59	.57	8.96
1928	19.99	5.47	3.19	11.33
Average	21.36	4.85	3.63	12.88

*From June 18 to December 31, 1926.
**The water lost through evaporation and percolation is not accounted for in these figures.

The average rainfall for the three years reported in the table is less than ⅔-inch below the seventeen-year normal and should represent, in a fair degree, normal conditions at Spur. The small isolated showers totaling 4.85 inches were ineffective. The 3.63 inches that was lost as runoff was not only ineffective, but destructive. Subtracting these two amounts from the total rainfall a balance of 12.88 inches remains on which to grow a crop. This last amount does not include the moisture that was lost through evaporation and percolation. The total amount of water that has been available for plant use has undoubtedly been less than ten inches annually. By certain cultural methods the water lost through evaporation can be reduced. Nothing can be done with reference to making available a portion of the water lost as ineffective isolated showers or the amount lost through percolation into lower strata. The problem then lies largely in preventing runoff. When the runoff is controlled the effective rainfall will be increased from ten inches annually to approximately fourteen inches, or an increase of 35 to 40 per cent.

The following is a summary of some of the other results of our studies:

Definite rain peaks occur in April and June and are followed by a dry midsummer with heavier rainfall occuring in August and September. Planting dates can be shoved forward in order to bring the crops into heavy fruiting under more favorable climatic conditions.

During the seventeen years there have been 861 rains with a total rainfall of 374.23 inches, 85 per cent of which occurred during the growing period of summer crops.

One-third of the total runoff during the three years occurred in August or at a time of the year when crops were making the heaviest demand on the soil moisture.

A plat with a one per cent slope planted to cotton lost over five times as much water during rain storms as a level plat planted to cotton. It does not require a steep gradient for water to move over the earth's surface.

A heavy grass sod is practically perfect in conserving water as the vegetative litter and grass tussocks furnish an excellent obstruction to water movement.

The runoff from land planted the previous year to cotton was three times as large as from land planted to milo. To the large amount of plant residue left on the surface from feed crops as compared with the relatively small amount from cotton is due in large part to the difference in water runoff.

Tillage is an important factor in the infiltration of rain water and many of the past practices have been erroneous. Much study has been given to the holding of the water in the soil after it has once been trapped, but further cultural studies are needed, having for their purpose the prevention of runoff.

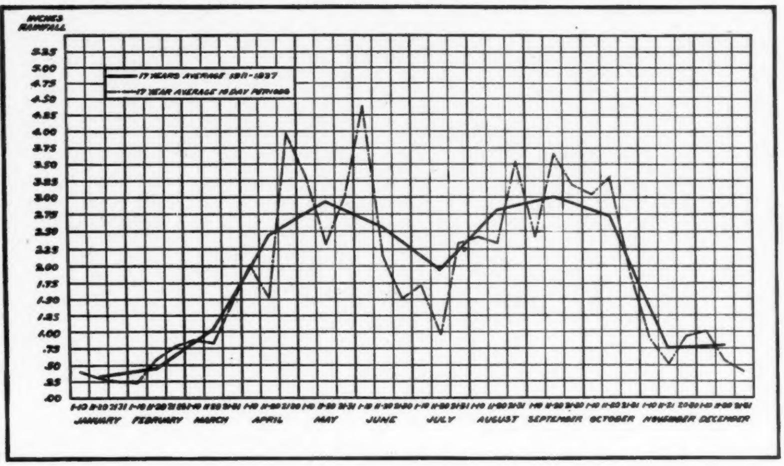
Level terraces have been much more effective than terraces having a slope along the terrace, in preventing runoff. There is little question but that the broad base level terrace should replace all other forms of terraces in the western portion of the cotton belt.

The impounding of water on the land where it falls has been found to be both practical and profitable at the Spur Station. Dikes were constructed around a ten-acre field; cross terraces were built and contour rows laid out so as to hold the water as nearly as possible where it fell. There was no water lost from this area during 1927 and 1928 and the crop yields were the largest of any area on the station farm. As the infiltration was rapid there were no bad effects from overabundance of water.

A small saving of water to be used at a critical time in the plants growth frequently makes a large difference in the harvest.

Sheet erosion, a process of skinning off the surface, is more destructive in the aggregate than gully washing.

A comparatively few torrential rains are responsible for the greater amount of soil wastage.



A dry period normally occurs in midsummer centering in July as determined by monthly rainfall averages. It was desirable to have more definite information on the duration of this dry period. The rainfall for 17 years was divided into ten-day periods which reveals the summer dry period covering a period of approximately sixty days, starting the middle of June and extending to the middle of August. Two well-defined spring rain peaks are shown, one during the last ten days of April and the other the first ten days in June. The conserving of the rainfall during these rain periods for use in midsummer is a very desirable practice

A hard dashing rain of 2.84 inches on July 9, 1926, eroded 12.46 tons of soil an acre from a plat with a three per cent gradient planted to cotton.

The construction of contours and the building of terraces is a comparatively simple operation. The average high school boy with the proper training in the fundamentals can become an expert.

It should be remembered, in all cases, that surface water can be more effectively handled and conserved when it has been robbed of its velocity.

Crop yields have been increased from 20 to 40 per cent by terracing.

There is probably no other service that the engineers of the country can render agriculture that is comparable with a complete study of the water and soil conservation problems. There is certainly no other way in which the agricultural wealth of the country can be so quickly and materially increased, and there is no program so lasting in its good results.

Soil Erosion and Water Conservation Facts from the North Carolina Experiment[1]

By F. O. Bartel[2]

RECORDS covering a period of 10 and 8½ years, respectively, on two dredged creeks in Piedmont, North Carolina, showed that these creeks were filling up at the average rate of a foot in 6 to 6½ years, where the grade of the channel was less than 11 to 12 feet per mile. This grading up of the bottom was accompanied by a widening of the channel as much as 50 per cent in the case of the larger stream. Where the slopes exceeded 11 to 12 feet per mile neither filling nor erosion took place.

Runoff and Erosion from Plots of Varying Length. The purpose of this experiment was to obtain data on soil and moisture losses from plots of varying length to serve as a guide in determining the proper spacing between terraces. The layout consisted of four plots, each six feet wide and planted to cotton. Their lengths were 37½, 75, 150 and 200 feet, and they were on a 9 per cent slope. Large tanks at the foot of each plot caught the runoff and eroded soil. The records cover a period of three years. A slight increase in both runoff and erosion were found as the length of plot decreased.

This result applied to the spacing of terraces would be absurd. Conditions are not comparable. In a terraced field the rows are run in a direction more or less parallel to the terraces while in the experimental plot they were run directly down the slope. Had we run our rows across the 6-foot plots we could have held the water in each row and prevented all runoff and erosion. Slight irregularities in contour and slope in a field cause a certain amount of flow in the rows. The water is carried to points of depression in the row, accumulates, the row breaks, and the water from several rows is concentrated into one stream.

The skill displayed in laying out and tending the rows will decide in large measure the amount of water and soil carried down into the terrace channel. The closer the terraces are spaced the less will be the concentration of water and consequent damage when the rows do break. Our experiment did show that the further the water ran over the ground the heavier was the silt burden it picked up.

Runoff and Erosion from Straight Crops. The layout for this experiment was similar to that just described, and was carried on at the same time and same location. There were four plots, each 75 feet in length, planted to a grass sod, cotton, corn and one bare; hoed just enough to keep down growth. The chief results are:

1. A definite erosion period was established which includes the four months of June, July, August and September. During this third of the year occurred almost half (45 per cent) of our rainfall, two-thirds of our runoff and six-sevenths of our annual erosion. An inch of soil was eroded for every 160 inches of rainfall and every 65 inches of runoff as compared with 1170 inches of rainfall and 220 inches of runoff during the rest of the year.

2. From the standpoint of water conservation, it is highly important to control the runoff during September. In North Carolina it is practically impossible to get the farmers to do any work on terraces during the fall. We hear many reasons for this: The cotton hasn't been picked; the crops are being marketed; and incidentally they want to hunt, fish and discuss politics around the cracker

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[1]Paper presented at the 23rd annual meting of the American Society of Agricultural Engineers at Dallas, Texas, June, 1929.

[2]Associate drainage engineer, U. S. Department of Agricultural. Assoc. Mem. A.S.A.E.

Broken terraces of improper construction on a red clay slope of the Blue Ridge Mountains which is too steep for cultivation. On soil of this type it is generally useless to build terraces when the slope exceeds 15 per cent. Only permanent sod and trees can be depended on to protect such land in situations of this kind. (Right) Trees struggling for life on eroded and abandoned land in the Blue Ridge region

barrel in the little country store after a hard summer's labor. But there is also the very real objection that the ground during October and November is too dry and hard to plow. If the September runoff of almost one-fifth of the year's total was stored in the soil instead of wasted, this last objection would be practically eliminated. This moisture would also be highly beneficial to any winter crop on the land.

3. The cotton plot lost from 40 to over 200 times as much soil and from 4 to 18 times as much water as did the grass sod. From this and the results first given, it is evident that there are but three ways open to us to prevent our tremendous loss of soil: (a) Stop growing crops requiring summer cultivation; (b) use some such artificial means of control as terracing, to counteract the effects of cultivation, or (c) pass a law against it.

4. If we do terrace, our terraces must be built to withstand the heaviest rains. One-tenth of these rains which were followed by runoff caused two-thirds of the total erosion.

5. The life of this soil under the various treatments is indicated by the following figures, which give the time necessary to erode the upper 7-inches of surface soil:

No crop	47 years
Cotton	49 years
Corn	73 years
Grass	Several thousand years

6. The loss of plant food through erosion is estimated to be almost seven times as much from cotton and over four times as much from corn as that due to crop removal.

7. The runoff averaged 29 per cent of the rainfall.

8. The average absorption was 29 inches per year.

Effect of Winter Cover Crops. Our present work on this location is with the effect of simple rotations and of shallow versus deep plowing on runoff and erosion. The leading question to be determined is whether there is any appreciable lag or residual effect from a soil improvement crop when it is followed by a clean cultivated crop. That such is the case is indicated by the fact that on plowing up the grass plot of the original experiment which was done in May, it took two months for the erosion and runoff from this plot to catch up with the other plots having the same crop. The runoff in June was only a fifth of its normal amount, that in July about half, while during August the effect was negligible.

The one year's records with winter cover crops showed that these reduced erosion about 10 per cent. This is about as would be expected as the erosion from October to May is only one-sixth of the year's total.

There was practically no difference between the results from land plowed 3 and 6 inches.

Runoff from Terraces. Since June 1926, we have been conducting measurements of runoff from terraces, using the improved Venturi flume and self-recording instruments.

One of the most interesting results from these studies is the effect of grade of the terrace channel on water conservation. From a terrace having a grade of 9 inches in 100 feet, 32 per cent of the rainfall was lost as runoff, or slightly more than from the cotton plot in our tank experiments (29 per cent).

From a field having a three-year planting of cotton, corn and soybeans, and cotton, which was drained by a terrace having a grade of 7 inches in 100 feet, the runoff was only 14 per cent as compared with 29½ per cent from similar crops during the same period from the erosion experiment.

In an adjoining terrace with a grade of only 2 inches in 100 feet the runoff was reduced to 8 per cent as compared with 32 per cent during the same period from the tank measurements.

The three maximum rates of runoff from these terraces as given below show some rather unexpectedly high rates and also demonstrate the effect of grade on runoff. These were, for the terrace having a grade of 9 inches in 100 feet, 3.80, 2.08 and 1.83 inches per hour.

For the terrace having a grade of 7 inches in 100 feet, the runoff was 3.18, 1.93, and 1.67 inches per hour. For the terrace having a grade of 2 inches in 100 feet the runoff was 0.92, 0.92 and 0.75 inches per hour.

Two terraces laid off on a variable grade were unfortunately planted to a hay crop so no comparison with the above is possible. The maximum runoff was only slightly over half an inch per hour indicating the effect of a cover crop on the land during the summer months.

These figures ought to give food for thought to those so-called "practical men" who give lots of fall to their terraces so they won't "break over as easily."

There is a great need for accurate figures on the effect of terraces in stopping soil losses. So far, all we have is mere observation and testimony from terrace users. The author is anxiously awaiting the development of some sort of flume or other device for measuring the amount of soil carried down the terrace channel and lost from the field. He suggests that this device should consist of an arrangement for catching all the heavy material rolled along the bottom of the stream and a means of sampling the water that runs off to determine the amount of soil held in suspension and solution. Runoff is, of course, only indicative of the amount of soil lost.

The Bank's Interest in Soil Erosion[1]

By A. K. Short[2]

THE bank's interest in soil erosion may be, in so far as the Federal Land Bank of Houston is concerned, completely stated in one word—self-preservation. However, I shall discuss some of the phases of this subject as related both to credit for land purchase and for production.

Sound and constructive credit is based upon the ability of business to pay. Credit is advanced to individuals, but the security must rest upon the continued productiveness of the business that is being followed by the borrower. As hazards increase more security must be had and higher rates of interest must be paid. This is because with questionable loans the charge off accounts are more frequent.

Farm credit, whether for production or for the purchase of land, must be based upon the production of the land. For production credit the basis must be upon the production the current year, while the land purchase credit must be based upon the ability of the land to produce adequate revenue over the period of years covered by the loan. Any sure and safe system of farm financing for the purchase of farm land must be based upon credit extending over a period of years. Safe farm credit for the purchase of land must be insured by a constructive soil conservation program. This is necessary from the standpoint of both the lender and the borrower.

Production farm credit has been based for many years, and will likely remain so for years to come, upon clean culture money crops. The main money crop in Texas is cotton. The production of this crop has been the chief security for production credit. This is true with the local bank, the local credit merchant and other lending financial agencies. The acre yield of cotton in this state has decreased more than 30 per cent in the last 30 years. From the experiments conducted at the Texas Agricultural Experiment Station, at Spur, it has been found that soil erosion takes place faster on land planted to cotton than on soil planted to any other general farm crop. We know that most of our land that is in cultivation in this state is more or less rolling. We also recognize that cotton is and will always be our main field crop. In the majority of instances the purchaser of land, or the borrower of production credit, intends to pay a part, often a large part, of the loan from the proceeds derived from cotton.

Lending agencies that are making loans for the purchase of farm land, or for production credit, should take into consideration the rapid deterioration of our farm land under our system of cotton farming. They should lend their aid to a soil conservation program, not only from a business standpoint, but also from an altruistic standpoint, to assist in perpetuating the farm home on a substantial basis. In financing farm production credit for the individual farmers in this section, the rate of interest is higher and the security more exacting than in the more stable agricultural sections of the United States. This, of course, is because we have not yet followed a definite system of crop production and soil conservation, and do not cooperate in production and marketing as they do in some other sections.

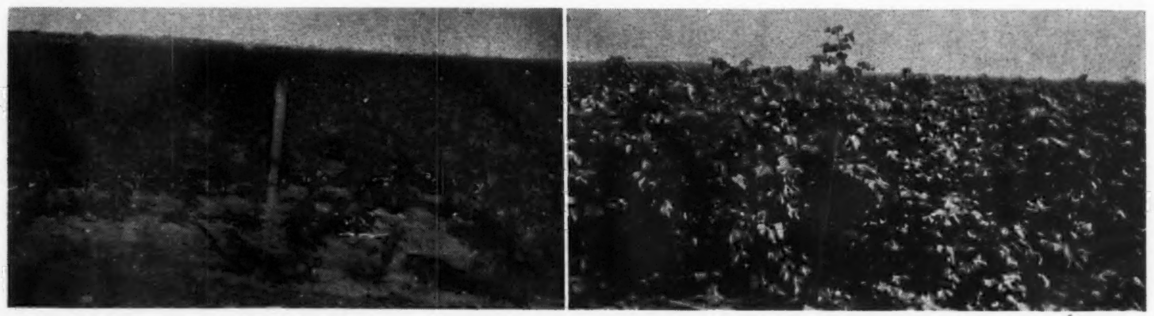
The ability of the farmer to pay on production credit is based upon acre revenue derived from farm crops. Acre revenue derived from farm crops is governed primarily by acre yield. High acre yield can only be produced from a fertile soil. These facts being true it naturally follows that production credit is a safer loan when made to a farmer who is practicing a systematic plan of soil building. It also follows that farm production financing is safe in communities that are practicing soil building. The truth of these statements is clearly set out by the fact that bank and other business failures follow in direct ratio the rise and fall of acre values of farm products. Farm production credit is always sound when advanced to the operator of a productive farm, and it is always hazardous when advanced to the operator of a poor, unproductive farm.

Credit advanced for production on a system of farming that leads to soil depletion is, at best, only temporary relief for the borrower and eventually becomes a detriment to the individual farmer, the community and the financial institution that furnishes such finance. This has been clearly demonstrated many times. Within the last two years, two out of three banks, located in one of the greatest farming districts of the state, failed. The majority of credit merchants also failed because the farm production credit was based upon a credit system of farming that led to soil depletion.

Farm production credit based upon a system that increases soil fertility stabilizes and insures farm financing and farming. This fact is clearly illustrated by the fact that the most prosperous country banks are found in the most prosperous farming communities. The past and present system, or demand, of production credit that has been followed by the majority of the lending agencies in the state, while being an immediate service to agriculture, has contributed very materially to destructive soil erosion and to the loss of soil fertility. This statement is not an indictment against anyone or of any class, but is an

[1]Paper presented at the 23rd annual meeting of the American Society of Agricultural Engineers, at Dallas, Texas, June, 1929.

[2]Conservation and terracing agent, Federal Land Bank of Houston.



(Left) Cotton on unterraced Miles clay loam at the Spur substation of the Texas Agricultural Experiment Station, in west Texas, September, 1928. (Right) Cotton on a terraced area of the same soil and slope and on the same date. The terraces were level and closed to hold all of the rain that fell


(Left) The last crop of cotton growing on subsoil that formerly was covered with rich black clay of the famous Houston type, in the Black Belt of Alabama. (Right) Rich, valley-filling soil, the Reeves silty clay loam, destroyed by erosion following overgrazing, near Chispa, Texas, in the Trans-Pecos country

indictment against our present lax system of farming and of our present system of production credit.

With the rapid deterioration of soil fertility that has been shown by experimental data and by actual field conditions, production credit should be based upon a system that will conserve the soil. If all agencies making loans for crop production should insist or require that all lands upon which crops are grown for security should be adequately terraced, the loans would be safe, the individual farmer would become prosperous and future generations would be guaranteed the necessities and comforts of life.

The advancement of credit for land purchase is based upon loans made for profit or is advanced by cooperative mutual credit associations. The borrower either purchases lands for speculation or for a permanent home. In all instances, where farm land is the basis of loans, the proceeds of the land are expected to liquidate the indebtedness. This simply means that the farm must support the family and in addition must produce sufficient revenue to meet the mortgage payments, and eventually pay off the loan.

All loan institutions desire money returns, and are interested only in the farmer being able to meet his obligations. All borrowers are interested in being able to meet their payments and pay off their loans. The farm must retain its fertility, throughout the life of the loan, if the farmer is to meet his obligations. On short time, high interest rate loans, the interest rate and quick maturity may maintain adequate security for the loan even under soil deterioration. That is, if the payments are not made the loan can be called while the land security is adequate. On long time, low interest rate loans on rolling lands the security may deteriorate more rapidly than the loan is amortized. When we recognize that on the average there is twenty times more plant food lost from erosion, on rolling land, than is used in crop production, it becomes evident that the first step in stabilizing farm security is the terracing of all rolling lands. Land that is terraced is fertile, or may be made fertile. Rolling, washing land is infertile and cannot support families and pay farm mortgages.

To clearly illustrate the federal land bank's interest in soil erosion, let us take the results on soil erosion from the Texas Agricultural Experiment Station at Spur. These data show that land with two feet of slope in 100 feet, planted to cotton, is washing at the rate of six inches in sixty-eight years. This first six inches of soil is the basis of production on the farm and is the basis of land security. Washing six inches in sixty-eight years is equal to a rate of 1.47 per cent per year.

The federal land bank amortized loan is for thirty odd years and starts with 1 per cent per annum payment on principal. It does not take an expert mathematician to see that soil erosion takes place faster than payment on the principal of the loan. The margin would start out with a difference of 0.47 per cent between soil erosion and payment of principal the first year. The difference grows greater up to the eighth year where soil erosion over the entire period is 2 per cent greater than the total payment on principal. From the eighth year the difference grows less. It should, however, be remembered that in an amortized loan the payments are the same for each period throughout the life of the loan. Consequently, if the loan is made at the maximum limit of safety, there is but little chance for the loan to be paid unless the farm maintains its original yields throughout the life of the loan. The only guarantee that yields will be maintained is prevention of soil erosion.

While no definite data were obtainable at the time, the directors of the Federal Land Bank of Houston recognized this truth early in the history of its operation, and for more than ten years there has been a terracing clause in the deed of trust. This clause clearly sets forth the fact that if the farm is washing, the bank being the sole judge, the borrower must terrace the land or pay the loan. Up until the present time the bank has never had to exercise this option. We have preferred to lead by education rather than drive by law; however, the Federal Land Bank of Houston is insisting that the borrowers terrace all rolling lands to insure the permanency of soil fertility during the life of the loans.

The federal land bank system is composed of cooperative farm financing associations. Cooperative credit is the most exacting credit known. A member of a national farm loan association who allows his farm to deteriorate by erosion not only injures himself and family, but also injures the securities of the association, and eventually imposes a financial burden upon the individual members of the association. This, in a lesser, though no less positive degree, has its effect upon the entire system. The perpetuation and soundness of the system is based entirely upon the securities offered and maintained. It then follows that the bank's financial interest in soil erosion is based upon its interest in the individual borrower, the national farm loan associations and the system as a whole.

Aside from our financial, or business interest, we are entering into the soil conservation program with the Texas A. & M. College and other agencies, because the Federal Land Bank of Houston is an institution whose capital stock is owned by the national farm loan associations, whose stock in turn is owned by Texas farmers, and each and every individual in the system is interested in the welfare of the Texas farm home and in Texas institutions.

The Economics of Preventing Soil Erosion[1]

By H. H. Bennett[2]

TOPOGRAPHIC surveys and widespread observations indicate that more than 75 per cent of the land of continental United States now in use for crops and grazing has a slope of 2 per cent or more. Observations and quantitative measurements of runoff and washoff show that most of this is subject to erosion in some degree, depending on the slope, the character of the soil, the density and kind of vegetation, the kind of treatment the soil has received, the depth to which erosion already has proceeded and the climate, chiefly the amount and intensity of the rainfall. Probably half of this vast area, or 37 per cent of the total area of tilled and grazed upland, is subject to serious erosion.

At the Spur substation of the Texas Agricultural Experiment Station in Dickens County, west Texas, on a 2 per cent slope of an extensive agricultural soil (the Miles clay loam), 27 inches of rain falling in one year removed approximately 40 tons of soil per acre from fallow ground (1)[3]. The precipitation in this instance was about 6 inches in excess of the mean rainfall for the region, but it was not the record for the region. On a 3.7 per cent slope at the Missouri Agricultural Experiment Station at Columbia, Missouri, a phase of the Shelby silt loam, a very extensive agricultural soil in northern Missouri and southern Iowa, and occurring also in some of the other states of the Central West, lost, from land cultivated 4 inches deep, 41.2 tons of soil per acre, as an annual average of 6 years, the average precipitation being about 35.8 inches (2). In North Carolina, the Cecil clay loam, sandy phase, a very extensive soil throughout the Piedmont Plateau from Virginia to Alabama, lost 25 tons per acre with 35.6 inches of rainfall on a 9 per cent slope (3). Rough field measurements made in the fall of 1927 on the extensive and important loessial soil of northeastern Kansas showed that a single rainy period following the sprouting of fall-sown grain removed at least 40 tons of soil per acre from thousands of fields having a slope of about 2 to 7 or 8 per cent. It was estimated at the time that a decade of crop rotations would be necessary to restore the losses of soil humus and available plant food taken out of the fields by these destructive downpours. Practically the same thing was repeated in the same region and over the same type of soil in the adjoining states of Iowa, Nebraska and Missouri in the fall of 1928, and again in the spring and summer of 1929.

Throughout the vast grazing region of the West, including immense areas in western Texas, New Mexico, Arizona, Colorado, Utah, Nevada, California, Idaho and Oregon, erosion, following excessive grazing on both lowland and upland, is severely impairing the stands of palatable plants. As an example, in the summer of 1928, a heavy rain fell upon a hard-grazed sloping area in southern Utah. Field estimates on a representative slope showed a loss of soil ranging from 4 to 18 inches in depth over about 80 per cent of the measured areas. The humus soil layer was bodily removed from most of the ground, and with it the scattered bunches of grass, resulting in tremendous damage to the range—an impairment from which recovery must necessarily be extremely slow, since plants do not reestablish themselves rapidly on such exposed "raw" material void of organic matter.

These and numerous other data indicate that something like a third of the land now used for crops is suffering greatly from the direct effects of sheet erosion and gullying, and, further, that something in excess of half of the western grazing lands is undergoing continuous erosional damage, ranging in effect from moderately impoverishing to absolutely destructive.

The products of erosion—clay, silt, sand, gravel, cobbles and bowlders—are being deposited over rich alluvial areas, in irrigation ditches, reservoirs, stream channels and harbors, and over highways, in culverts and about farm buildings.

Loss of Soil and Plant Food. Minimum estimates indicate that the crop lands of the nation are losing twenty-one times as much plant food by erosion as is annually lost (net loss) by the crops taken off (4). In addition the soil that contains the plant food is being lost. This removed soil, together with its plant food, cannot be restored to the fields and ranges; but the plant food taken out of the soil by crops can be restored in the form of commercial fertilizers, barnyard manure and humus from soil-improving crops.

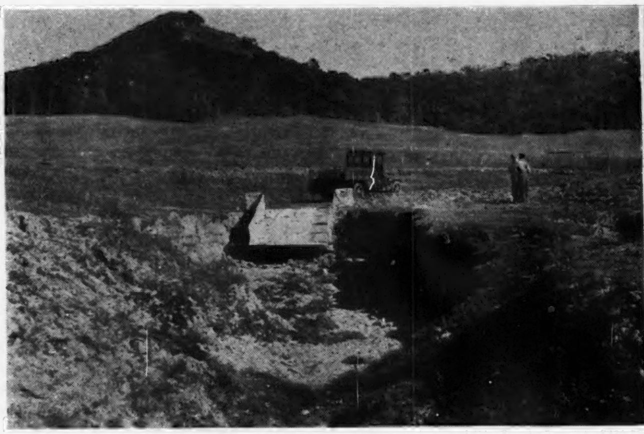
Available data show that erosion is far more damaging in its impoverishing effects on both crop and grazing land than is commonly believed, and the indications are that the evil process is gathering momentum. This abnormal erosion is largely directly chargeable to disturbance of the ground equilibrium by removal of trees, herbaceous growth and grass, and by plowing and excessive grazing. An enormous amount of damage obviously is being done,

[1]Paper presented at the 23rd annual meeting of the American Society of Agricultural Engineers, at Dallas, Tex., June, 1929.

[2]In charge of soil erosion and moisture conservation investigations, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

[3]Figures in parenthesis refer to the literature cited following this paper.

(Left) Ungrazed, grass-covered soil inside of the fence. (Right) The same kind of soil and degree of slope showing the effects of overgrazing




(Left) A sheet metal flume to conduct water into the head of a rapidly expanding gully without washing. The scene is in Wisconsin. (Right) Gully erosion under control by second-growth pine, in Anson County, North Carolina, on White Store clay loam

also by wind erosion which frequently works hand-in-hand with the scouring and abrasion by running water. We have, as yet, little knowledge of the extent of land damage by wind, further than the self-evident fact that it is very great in many parts of the country and goes on to some extent in most regions. That there are sharp textural soil boundaries in most localities shows, however, that wind is far less effective in this respect generally than water.

There are not available sufficient quantitative data relating to the destructiveness of the processes of erosion to give an accurate statement of the cost to American agriculture or the probable cost to the future of the Nation. Every year erosion is adding to our area of marginal land and to the area of land permanently destroyed, from the standpoint of cropping and impoverished from the standpoint of grazing and timber growing; but we do not know how much this depreciation and destruction amount to. Neither do we have any accurate measure of the amount of damage that already has been done throughout the Nation, nor of the area that already has been abandoned as a result of erosion. Measured areas here and there, such as 91,000 acres in Fairfield County, S. C. (5), and 73,000 acres in Stuart County, Ga. (6), formerly tilled and now either permanently or practically destroyed, indicate that not less than 17,500,000 acres of formerly cultivated land have been destroyed or so severely gullied that it would be entirely unpracticable or impossible for individual farmers to reclaim any considerable part of it. But we do not know that this estimate of destroyed farm land covers the full extent of this extreme erosional damage, or even that it covers half of the area of land that has been ruined by rainwash. We do know, however, that this severest phase of erosional wastage is small in comparison with the damage that has been done by sheet erosion, though we have no accurate measurement of the relative extent of the damage.

Relation of Erosion to Soil Type. Some soils are far more susceptible to the evil effects of erosion than others having the same slope, the same vegetative cover and the same climate, and which have been used for the same crop cultivation in the same way. We understand the cause of these differences in the instance of some soil types, but not in others. As yet we have not fully classified the various types of erosion or even undertaken to interpret all classes of erosion in their individual relationships to the environmental impress. Again we have not as yet obtained for all soils and slopes the fundamental data necessary for sound engineering, forestry and agronomic procedure in connection with erosion-control devices; tree, shrub, vine and grass planting systems; and cropping schemes. In other words, we have been exceedingly slow to attack the problem, and we know little about the fundamentals relating to it, especially the soil type relationship.

Why, for example, did 27 inches of rainfall in west Texas remove 40.7 tons of soil per acre from a 2 per cent slope of fallow ground, when 35.6 inches of rain removed only 25 tons per acre from a 9 per cent slope of fallow ground in the Piedmont of North Carolina? At both places the soil was a clay loam, the ground was in a nearly undisturbed condition, and much of the precipitation came as torrential rains. The answer appears to be that the cause was purely and directly a matter of soil structure. Texturally the two types were essentially the same; (the North Carolina soil containing a little more sand, which normally might be expected to add to the erosivity); structurally they were widely different. On drying the west Texas soil cracks and recracks to develop a loose surface condition with numerous small hard soil fragments that move down the slope easily under the impact of flowing water. The weaker fragments or crumbs tend to "melt" with wetting to form a pasty mass, but the true fragments are generally relatively hard and resistant. The combination doubtless has something to do with the ready erosivity, but actually we know little about the process, not having studied it very critically.

Some western soils assume such a deep, loose structure due to this process of fragmentation and granulation, a process strongly characteristic of clays and clay loams, having a high content of water soluble salts, that the slightest ground disturbance, such as a puff of wind or the tramping of stock, sets the mass in motion. This is a feature of considerable significance in the western grazing country. The granular-fragmental material tumbles or cascades down the slope in such a way as to add greatly to the effectiveness of erosion. The sides of gully walls in some of the common valley clays of the western grazing region, such as the valley phase of Reeves silty clay in west Texas and New Mexico, flake off or crack off on drying to hasten lateral spread of water-eroded trenches. Thus erosion (or its equivalent) proceeds through the dry season as well as the rainy season in these subhumid and arid regions. Consequently it is necessary here for soil conservationists to combat not only excessive runoff but soil fragmentation and the force of gravity. This means, of course, that vegetation must be reestablished over the steeper, rougher areas of the neighboring watersheds, if grazed land is to be preserved or given reasonably safe protection.

Another soil peculiarity that must be dealt with by the soil conservationist is the weak structure of the highly silty loessial soils that occur so extensively over the

hills and slopes bordering the Mississippi and Missouri Rivers from Wisconsin and South Dakota, respectively, to Louisiana. The terraces that have been built to hold these lands—those in the southern part of the region in particular—have generally failed. These lands and some other similar types, such as the Cincinnati silt loam in southern Ohio, are highly erosive. Sheet washing planes off the topsoil (the A horizon) rapidly, and when gullies have cut through the subsoil layer (the B horizon) of silty clay loam, into the substratum of soft, unstable silt (the C horizon), canyonlike gullies rapidly dissect the sloping areas. The material of the silt layers (the A and C horizons) has the appearance of melting when heavy rains fall on it, especially where the humus layer (the A horizon) has been washed off. The soil particles of this silty material behave very differently from those of the granular-fragmental soil types referred to above. Instead of flocking together in granules, or cohering into a dense, massive structure, with subsequent splitting into resistant blocks (on drying), they stand apart as individual grains, unprotected and susceptible to ready suspension and removal in the runoff. It is possible that terraces on land of this kind will have to be stabilized with grass or shrubbery, or perhaps even treated with flocculating chemicals.

In the Piedmont Plateau, east of the Southern Appalachians, there are important redlands, the Davidson soil, locally known as "push" land because the soil will not scour over the moldboard of plows, which are far more resistant to erosion than the associated yellow soils of the Iredell types. The Davidson soils are highly weathered and contain much iron in a highly oxidized state. They not only are more resistant to erosion, but are not nearly so sticky as the highly erosive Iredell soils, and they do not swell or shrink at the extremes of moisture content nearly so much as the Iredell types. Also they are much more friable. The constituent clay particles, the colloids, appear to be flocculated in such a way that there is greater pore space, through which water percolates much more freely than is possible with the highly dispersed, dense material of the Iredell clay. The pores of the latter material are so small, capillarity overcomes percolation.

Similar physical properties characterize the redlands of east Texas, west central Louisiana, and southwestern Arkansas (the Nacogdoches soils), and the splendid fruit-producing redlands of western Oregon and Washington and northern California (the Aiken soils). The typical red soils of the Northwest are almost erosion proof.

These resistant soils are lateritic in character. Chemically, their ratio of silica to iron and aluminum is low in comparison with that of the highly erosive, sticky, plastic clays, such as the extensive Iredell and Susquehanna clays.

In the humid tropics a striking soil feature is the great depth and advanced state of soil weathering in most well-drained situations, where the soil has long lain in an undisturbed condition. For example, the Aragon clay (7) of east central Costa Rica, containing less than one per cent of sand, is so friable and so lacking in stickiness it can be readily and safely plowed in the rain. It absorbs so much of the rainfall, amounting in some localities to 155 inches annually, and is so resistant to suspension in water that the small runoff from heavy downpours is scarcely turbid, as a rule. Much the same is true of the red Matansas and Nipe soils of Cuba (8).

These friable tropical soils are true laterites. They are very low in silica, high in content of iron and moderately high in alumina. Some of them, as the Nipe clay, have been so leached that most of the silica has disappeared, all or nearly all of the lime is gone and most of the other bases, along with the greater part of the potash and phosphorous. In such extreme cases of weathering, the material might be looked upon as soil in the death stage. These true laterites absorb practically all of the rainfall, they are extremely friable, almost void of stickiness, practically static as to volume change at the extremes of moisture content, and when shaken in water the particles quickly drop out of suspension. The pore space is large and percolation rapid. Capillarity is so nearly negligible that the soils quickly dry out to depths of 4 or 5 feet, retaining no visible moisture whatever after a few weeks of dry weather even down to depths of 3 or 4 feet in some types, as the Truffin clay of Cuba. In the Nipe Mountains of eastern Cuba the parent rock (serpentine) has weathered to depths of 50 feet or more in places. Pick marks left in exposed situations stand for a year or more without change, regardless of heavy rains. These soils contain almost no sand. But for the presence of ferruginous pellets, or concertions or accretions, they would analyze about 100 per cent clay and yet they have none of the properties of clay, as we of temperate zones have commonly understood the characterizing features of clay soils, such as extreme stickness, high plasticity, impermeability, density, and high capillarity.

The types referred to as resembling laterites, that is, the Davidson, Nacogdoches and Aiken clays, have some approximation to the physical characteristics of these highly weathered tropical soils (9). Because of their high absorptive capacity, it is believed, for example, that much more nearly level terraces could be used on them (perhaps even level terraces) than on the associated less absorptive humid region clays, such as the Iredell and Susquehanna.

Stratigraphic Soil Features and Erosion. The relation of soil material to the problem of erosion is entirely different from the relation of the stratigraphic characteristics of soils to the process. This phase of the subject is too broad to discuss in detail here, even though it is of enormous importance. Generally speaking, those soils which have unstable substrata, such as loose sand, soft

(Extreme left) This Iowa field is slowly losing its soil by sheet erosion. Yellow clay is already exposed in the wash and the soil has been greatly reduced in thickness all over the field. (Left) An over wash of loose sand left on an alluvial meadow near Lyndon, Vermont, by the flood of 1927. The meadow grasses have largely been killed

silt and rotten rock, suffer seriously from rapid gullying on unprotected areas. Where rotten rock is the basal material, the gullies are usually V-shaped, with a strong tendency to split into laterals. Where the corresponding layer is sand or silt the gullies are more inclined to be straight-walled and straight-lined axially. They cave at the heads and along the sides from water going in over the banks, and branch with extreme rapidity. This is the most destructive type of gully development and the most difficult to control. The use of ordinary dams is not at all a sure means of checking their growth. After a gully of this type is well under way about the only practical way to put it under control is to make use of structures that will prevent water from entering the gully in the form of a direct waterfall, either at the head or along the sides. Metal or wooden flumes, protective lateral terraces, and porous dams have been successfully used in checking their extension in parts of southwestern Wisconsin. In 1928 the county agent of Buffalo County, Wisconsin, was undertaking to save a fertile valley dairy farm, which was about to be destroyed by a rapidly growing gulch near the center of the valley and parallel to its axis, by conveying the slope water up the valley by means of terraces, and passing it into the head of the gully over a metal flume. Suitable outlets had not been found below, and so this method was followed. It appeared at the time as if the undertaking would prove successful.

A peculiar type of gullying characterizes the silty soils having hardpan or compact layers of incipient hardpan at comparatively shallow depths, such as the Grenada soils of northwestern Mississippi and western Tennessee (10). Here sheet erosion removes the surface (the A horizon) and gullies cut through the clay subsoil (the B horizon) down to the hardpan or incipient hardpan (the B_3 horizon), where the rate of erosion slows down to some extent. While the downward cutting is going on, lateral erosion works back along the edges in such a way that the gullied areas are frequently as broad as they are long. This radial-extension type of gullying usually leaves in its wake completely devastated land, such as can not be reclaimed by any method of practical farm application.

Still another distinct type of erosion is that characterizing the exceedingly plastic, heavy clays, such as the Iredell, Susquehanna, Lowell and Fairmount[4]. These tough clays are so adhesive that water cannot readily prize the grains apart. If only clear water runs over them, there is little erosion, save that which removes the loosened particles formed when the soil dries, shrinks and cracks into blocky fragments. Muddy water, however, especially that containing sand, gradually abrades the clay material to form broad, shallow gullies, with gently sloping sides. These can be checked with simple and fairly cheaply constructed dams.

In this connection it might be observed that muddy water, generally (if not always) is much more abrasive than clear water.

Alternating straight-walled and V-shaped gullies develop in sandy soils having (a) sandy clay subsoil in close association with (b) sandy soils having stiff clay subsoils, such conditions as characterize parts of the Red Plains region of Texas and Oklahoma. Abrasion cuts rapidly through the sandy clay subsoil to develop gullies with straight walls, where V-shaped gullies would normally develop if the water contained but little sand. Coming in contact with the associated type having stiff clay subsoil and possessing greater resistance to erosion, there is a tendency for the same sand-charged water to cut broad gullies with gently sloping faces, and, also, a tendency for the gully to turn aside, seemingly, in an attempt to avoid the tough clay. These characteristics may seem trivial at first thought. Actually, they may seriously affect the permanency of small check dams. If the check dam is put in along the contact between the stiff clay and sandy clay, with the latter on the lower side of the dam, the structure is likely to go out rather quickly as the result of undermining by waterfall effect on the lower side.

Where a sandy clay overlies a heavy silty clay, gully erosion in the arid regions is not so disastrous as where the textural stratigraphy is the reverse, provided that the sublayer is not composed of uncemented sand and gravel. This is due to the fact that the sandy clays of dry regions do not as a rule, develop the columnar structure so characteristic of dry-region, non-sandy heavy clays. This vertical splitting speeds up gully expansion by blocking off and causing to fall in large masses of soil from the sides, and hastens the development of laterals along the lines of splitting. In the former instance gully control would be largely dependent on the installation of efficient dams; in the latter instance both the sides and heads of the gullies would have to be protected from the disastrous effects resulting from direct entrance of water. Without such protection, dams probably would not be very durable.

Numerous other peculiarities of erosion are directly or indirectly related to soil character, such as the tunnel type of gully development, where rodent holes and holes left on the decay of plant roots enlarge and finally cave in; the vertical type of bad-land erosion; the shelving type of bad-land erosion; silt erosion, and shale-soil erosion. It will not be practical to discuss all of these types (and others not mentioned) in a single paper.

The Soil Cover. Soil character and stratigraphy are not the only factors governing erosional processes and destruction, although probably no other factor, save perhaps, that of cover, is of more importance.

The character of soil cover is of such great importance in preventing erosion that it would probably be not far from correct to say that with a good soil cover erosion is comparatively inactive. At the Missouri station it was determined quantitatively on the Shelby silt loam that while a seven-inch layer of soil was being washed from fallow soil tilled 4 inches deep in 24 years and from continuous corn soil in 55 years, the same kind of soil was being removed from bluegrass sod, on the same slope, at the insignificant rate of 7 inches in 3,547 years. The run-off from fallow ground was approximately 49 per cent of the rainfall and from corn, 27 per cent, whereas only 11.5 per cent was lost from grass. Bermuda grass at North Carolina held back 415 times as much soil as bare ground and 215 times as much as cotton. It also held back 53 per cent more of the rainfall than was retained on bare ground. Buffalo grass at Spur, Texas, some years has held back all the soil and most of the rainfall.

The Blue River of Nebraska and Kansas never under any circumstances, now, gets clear, although it was named because of the clearness of its waters. The change came with the extensive breaking of the native prairie sod, according to those who have witnessed the transformation from a stream of clear water to one of permanently muddy water. Nearly every old inhabitant of the prairies tells of streams that seldom or never ran dry, something like a generation ago, which now, in summertime, carry water only for short periods following rains.

With a good ground cover of forest mold there is practically no danger of erosion beyond the geologic norm, concerning which mankind need have little fear. Even the chaparral and mixed chaparral and grass of the Southwest, duly protected from fire and overgrazing, give good protection to the land.

The Future. But we can not keep all of our land in timber and grass. True, many millions of acres now in crops should be turned back to forestry or to grass, nevertheless we shall continue to need large crops of wheat, corn and cotton that can not be grown under the shade of forest trees nor on unplowed prairie sod. In order to protect or partially protect our tilled lands from the wast-

[4]These soil types are described in various soil survey reports of the Bureau of Chemistry and Soils, U. S. Department of Agriculture.

(Left) An example of erosion in southern Indiana. (Right) A field which has been preserved since Colonial days, though continuously in cultivation, by the practice of good crop rotations. The field is in southern Maryland in a locality where much erosion has taken place

age of erosion, it is going to be necessary to do something to stop the rate and amount of runoff water. Continuation of the present methods of land usage can lead to but one thing: The conversion of very large areas into poor land or worthless land. At the present time most of our good land is in use. Economists tell us that fifty years hence we probably shall still have large areas of arable, food-producing land. This, doubtless, is true. But fifty years is a very short period in the life of a nation—it should be, at any rate. It is probable that we shall not be starving on a wholesale plan fifty years hence or even a hundred years hence.

It is, nevertheless, pertinent to ask what kind of land will this reserve supply of fifty years hence be. Will it be good land or poor land.

If what has taken place already means anything, it means, certainly, that these reserves will be either poor land or land that is not so productive as was the virgin soil. This situation will apply, of course, more specifically to our rolling lands. As a matter of fact, a considerable part of our present harvest is coming from land that was either poor in the virgin state or has been poor through the enfeebling effects of erosion. It is not necessary to look fifty years hence to the probable state of prosperity in the case of those farmers operating on worn-out soil. We have many thousands of farmers throughout this country who are not getting ahead with their farming operations. They are remaining stationary, financially speaking, or are going deeper and deeper into debt. In some states the sale of land for taxes is steadily increasing. A large proportion of the distress is directly due to soil erosion. Farmers are dropping out of their lifelong business to try their fortune in other lines of industry. Their lands have been washed to such a state of poverty that they are unable to make a living, except by foregoing everything but the bare necessities of life. Nevertheless, these marginal farmers are producing in the aggregate, enough to add largely to our annual yields.

When the Topsoil Is Gone. Again we are told that production is increasing on the farms of America. With increasing use of fertilizers and soil-improving crops, and with increasing use of improved machinery for rapid planting, tilling and harvesting of crops, and with improved seed and better varieties, this is but the natural outcome on good land. The curve will go in the opposite direction, of course, as soon as the soil has been washed off down to unproductive clay, gravel or rock, on a sufficiently large area of land to make it impossible to apply the present plan of abandoning the worn-out fields and turning to those where there still remains a layer of topsoil. There is no question about the soil washing off under the present system of usage on most land having any considerable slope.

When the topsoil is gone clay is usually exposed, this being the predominant subsoil of our farm lands. This is stiffer and more difficult to till than was the more loamy soil washed off. Being less permeable and more susceptible to baking with desiccation than the loam, it absorbs water slower and loses it quicker in dry weather. Rainwater flows off the relatively impervious material at a quicker rate. The content of available plant food is lower, and in order to maintain yields, fertilizers or soil-improving crops must be used. In many instances, the subsoil is more erosive than was the soil, and the common substratum of soft material below the clay is more erosive than was the clay subsoil. Therefore, erosion becomes progressively more damaging in its effects as time passes. This partly explains the situation in some parts of the country, such as northern Missouri and southwestern Wisconsin, where the complaint is frequently made that erosion has been much worse during the past seven or eight years than ever before. The other part of the explanation doubtless is that it took twenty to forty years to whittle off the foot or so of virgin soil and subsurface layer down to the subsoil.

In connection with the gradual removal of the soil by sheet erosion, it should be observed that the soil itself is less productive in its lower part, the lighter-colored subsurface layer (that soil scientists refer to as the lower part of the soil, or the A_2 horizon). The most productive part of any soil is the darker colored surface layer, that is, the humus layer or "vegetable cap" (capa vegetal), as it is referred to by our Latin American neighbors. We sometimes hear the statement that certain soils are a foot deep, two feet deep, or that "the soil has no bottom." Perhaps the average thickness of the true surface soil, the most productive and valuable part of any land, is not more than about 6½ to 7½ or 8 inches deep for the sloping uplands of humid America.

With the removal of this surficial layer, most types of soil are much less productive than they were in the virgin state. This is true even of deep, loose sands of the coastal plain regions, which in some instances after losing the surface few inches containing the main supply of humus, can not be cropped successfully to certain crops, such as potatoes, because the crops are liable to "burn" when enough fertilizer is applied to the "raw" subsoil to give a satisfactory yield. Not having much humus, there is not much soil moisture in dry times, hence the soil solution is likely to become too concentrated if fertilizers are applied too liberally.

Apparently it is not a bad idea to appraise a soil in accordance with the method which the Houston Land Bank has used, that is, to look upon the surface six inches as constituting the farmers' main capital. With many fields losing 40 tons of soil per acre per year, and some in excess of this, it is seen that it takes 27 years or less to remove the 1,080 tons of soil constituting the average layer of upland topsoil.


(Left) This 8-foot dike was built to intercept erosional debris that was coming down from the neighboring hills and damaging highly productive corn land in the Missouri River bottoms of Kansas. Deposition at the rate of 1200 tons per acre per year raised the level of the 40-acre field back of this dike to the level of its top in ten years. (Right) Unproductive white chalk exposed by erosion in the Black Belt of Mississippi. This basal material was formerly covered by extraordinarily fertile black clay

Conclusion. Dole and Stabler have estimated that 513,000,000 tons of suspended matter and 270,000,000 tons of dissolved matter are transported to tidewater every year by the streams of the United States, the Mississippi alone carrying 428,715,000 tons of the suspended matter (11) (there are reasons to believe that these estimates are much too low). There is no measure of the amount of soil material annually washed out of the fields of the Nation to be deposited somewhere en route to the sea, usually where it is not needed or where it actually damages the land; but simple observation shows that it is many times greater than the amount that actually reaches the ocean every year (it may be a hundred times greater, or much more than this—no one knows). There is abundance of evidence that the estimate of 1,500,000,000 tons of soil material annually washed out of our American fields is exceedingly low. Even so, the amount of plant food contained in this is about 126,000,000,000 pounds, on the basis of the average analyses of 389 samples of surface soil collected throughout the country.

The value of the phosphoric acid, nitrogen and potash in this lost material annually amounts to two billion dollars on the basis of the cheapest commercial fertilizer materials. We shall not say that the farmers are annually paying this much toll to soil erosion, but there is every reason to believe that the direct cost to the farmers is not less than $200,000,000. It may be considerably more. In addition, there is an irreplacable loss to the Nation in land destroyed or irreparably damaged; in the silting of waterways, harbors, ditches and reservoirs; in damage done to highways, culverts, and railway fills; and in damage done to rich alluvial lands by overdeposits of relatively infertile sand and gravel.

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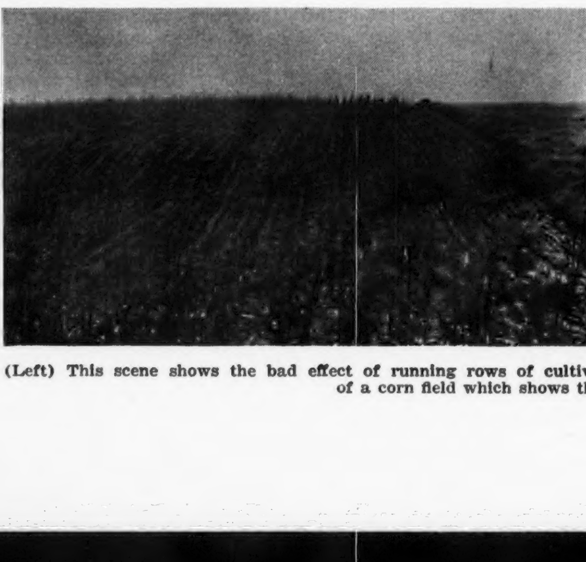
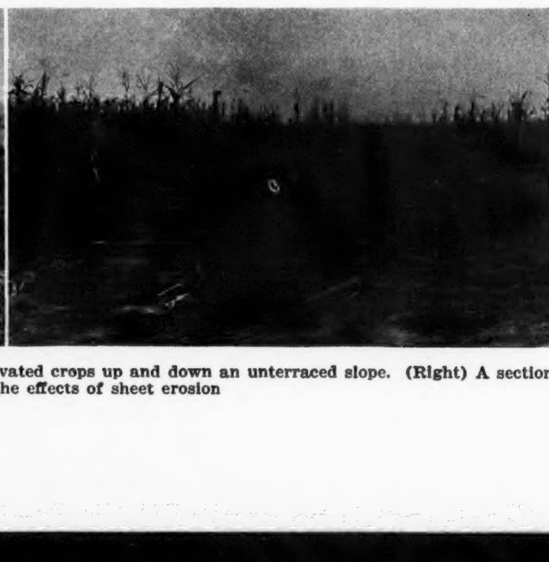

(Left) This scene shows the bad effect of running rows of cultivated crops up and down an unterraced slope. (Right) A section of a corn field which shows the effects of sheet erosion

Promoting Terracing Work in Texas[1]

By M. R. Bentley[2]

IT MIGHT be assumed that the Southwest is sold on terracing. I believe that terracing has been sold, but if you will travel over the Southwest you will see that only a part of the goods have been delivered. In Texas we have some pride in the amount of good terracing that has been done. At the same time we are ashamed of the fact that our cropping system is such that the land washes much faster than it would if we did not plant such a large portion of our land in cotton.

We estimate that nearly three million acres have been terraced in Texas. There are still some eighteen million acres of land in cultivation that should be terraced at once. The terracing of any considerable acreage has been going on for about fifteen years. If terracing continues with the normal increase in acres terraced per year, we will be through in twenty years. We hope to complete the job in ten years.

Very little terracing has been done on rolling land until erosion has caused the crop yield to fall about 50 per cent below that of new land, or the land has become badly gullied. In the western part of Texas where the rainfall is light, terracing and the contouring of the crop rows immediately increases the crop yields from ten to one hundred per cent due to the conservation of the rainfall, so it is unlikely that erosion will seriously damage the land in that region before it is terraced.

The promotion of terracing has been based on field demonstrations. Only about one man in a hundred will build terraces on his farm until after he has seen them on some one else's farm. We owe much to the few pioneers who accepted terraces on faith. The extension service of the A. & M. College of Texas makes no claim to starting terracing in Texas, as there were some terraced fields as long as forty years ago, in east Texas.

The county agents have been leaders in this work from the beginning of their service. In 1911 a state law provided for the appointment of a civil engineer to survey terrace lines for farmers half the time and teach terracing in the A. & M. College the other half of this time. During the next few years many counties employed county agents, who took over the work of surveying the terrace lines.

The work proposed by the state law of 1911, in the course of a few years, was carried on by the county agents, an extension agricultural engineer and the agricultural engineering department of the A. & M. College.

When county agents first began to survey terrace lines for farmers, the aim was to get some good terrace ridges built on properly surveyed lines to serve as an object lesson in a method of checking erosion. After a few years this surveying, that started out as a demonstration, became a regular everyday job for the county agent from about December first to March first; not as a demonstration but as an answer to very insistent requests.

Usually the intense interest in terracing was centered in a few of the communities of a county, so it soon became evident that some one or two farmers in each community should become surveyors for their community, as a matter of expendiency. This plan of getting the surveying done is what we are promoting now, and reports of fifteen years ago show that it was used at that time. Most county agents were adverse to turning over the terrace surveying to others, until the work became so heavy they were forced to because this work gave the agent a contact, and point of attack on other problems, difficult to get in any other way.

I do not mean to infer that the day is past when the county agent can get out and stage an old-fashioned demonstration in terrace surveying and construction to good advantage. In fact, I know of a few counties in Texas where demonstrations were put on in good shape ten to fifteen years ago, but evidently the people were immune at that time as the inoculation didn't take. They need more demonstrations.

The value of good work at the first in the community can hardly be estimated. In a few places the first field terraced had terraces about thirty feet wide built on it, with plenty of height. All of the terraces in the vicinity are patterned after these. If the first terraces a farmer sees are broad and large, and followed by the crop rows, he usually assumes that nothing less will do. A Texas county agent doesn't tell a farmer that straight rows work very well on terraced land. He tells him that he hopes the terrace ridges will survive until he learns to follow them with the rows.

When Mr. Dickson at Spur raises about twice as much cotton per acre on his crooked rows run level, as on the straight ones, with about one-half of one per cent grade, it looks like we don't have much land in Texas suited to straight rows.

Since tractors have come into general use over the state their use in building terraces seems to attract farmers to see the building work done. Like everyone else they like to see the "wheels go 'round." Getting the farmer to watch the building of the terraces is a step toward getting him to study the benefits of terracing. We have had excellent cooperation from implement and tractor dealers. In scores of instances a tractor dealer has brought a tractor out to the field and helped build terraces when he knew there was no possible chance of any direct return in tractor or implement sales.

Field tours and field meetings are excellent to let

[1]Paper presented at the 23rd annual meeting of the American Society of Agricultural Engineers, at Dallas, Texas, June, 1929.

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(Extreme left) Tracks of a grain seeder in a northwestern Kansas field being converted into gullies. In places the wheel tracks were washed to a depth of two feet during a single rainy period. They will grow into destructive gullies, as nothing is being done to stop erosion in this locality. (Left) Caving of Norfolk fine sandy loam in a roadside cut, due to the effect of washing on the soft basal sand

people know just what terraces are. We have not used the field tours as much as I think we should.

Publicity about terracing can spread only a few miles from a terracing demonstration except by the aid of farm papers and daily papers. The papers in this state have given generous space to news stories and feature articles on terracing. I think one thing that we have overlooked in the matter of publicity is that we have made it seasonal rather than keeping it up throughout the year. During recent months an Oklahoma farm paper has carried something about terracing in practically every issue of the paper. This fact has caused the readers of this paper in Texas to think that Oklahoma must be about all terraced.

Another form of publicity that county agents have used to some extent is the building of a model of a terraced farm at the community and county fairs. This has given some good results where there were not too many other attractions.

The banker who is a firm believer in terracing and will talk about it, can do a wonderful lot of good in getting farmers to terrace their lands. I have in mind a banker in a small town in Texas who got interested in terracing before there was a county agent in his county. After he had terraced his farms, he began talking terracing through the cashier's window to farmers until they would consent to terrace their farms to get rid of him. When a farmer would finally consent to terrace his land, this banker would step to the back of the bank and produce a farm level for him to lay off the lines with. When a county agent was eventually placed in this county, terracing flourished.

As a method of promoting the terracing program, especially in communities where the farms were small and the purchase price of a farm level would be a large item, the business firms of the towns have bought levels and loaned them to their farmer customers. Usually these business concerns have their firm names on the level, so that it serves as a circulating signboard advertisement. Chambers of commerce in many small towns have purchased from one to four levels to lend to farmers. During the last few years the chambers of commerce and business firms have offered farm levels as prizes in various kinds of enterprises where communities competed with each other.

The county agent can get the county commissioner to use a road grading outfit for a terrace building demonstration nearly any time he asks for it, if the outfit is not busy on the road. During the last three or four years in some twenty or twenty-five counties, these county outfits with the men to operate them have been placed on the farms to build terraces when they were not busy with the road work. The charge to the farmers for the outfit has been just enough to pay the operating expenses. In one county in Texas, four outfits were put on the farms during the entire season of about three months. This piece of work done on a big scale was very effective in getting farmers who were not particularly interested, to start terracing. When the road outfits are used at cost for building terraces, the expense to the landowner on the big sandy loam farms of west Texas is as low as 60 cents per acre, or about \$10 per mile; and on the black clay lands of central Texas as low as \$1.50 per acre, or about \$20 per mile.

When it comes to getting terracing to spread throughout a community, about the best means is to get some farmer with a level and the right kind of spirit working at the job. We have some instances in this state where one farmer during a period of eight or ten years has got practically every field within three or four miles of him terraced.

Some effort was made by county agents and the agricultural engineering specialist to get these farmer terracers started as long as fifteen years ago. Some three or four years ago in several counties of the state it appeared that the greatest need in getting terracing done was more men to survey the lines. About three years ago we concentrated our efforts along this line. To accomplish this we have held numerous meetings called terracing schools where we made it known by precept and practice that our principal aim was to train a few men to run terrace lines. Some hundred counties have held ten or fifteen community terracing schools. About two years ago the Federal Land Bank of Houston appointed a conservation specialist who immediately joined in on an extension service program in conducting terracing schools over the state. The Federal Land Bank of Houston and the extension service of Texas A. & M. College have worked in harmony from the founding of the federal land bank, on promoting terracing.

About two years ago at the beginning of this continuous terracing campaign over Texas, the Texas Agricultural Experiment Station at Spur came out with the first results of their experiments on erosion. These results confirmed many things that we thought we knew, and showed much greater losses from erosion than we suspected. They have been told freely over the state. The results of the work of the Spur station have been explained in 200 meetings in 140 counties to approximately 14,000 men.

We expect that the new erosion experiment stations will show that soil losses are larger than most people realize, thereby stimulating action on terracting, especially in the central part of the state.

A terracing club for boys is conducted by the extension service. Medals and trophies are given the boys who survey the most terrace lines for actual use. Last year one boy ran lines on twenty-five farms. Nearly all of the vocational teachers use terracing as a major project with their students. A very considerable acreage is surveyed for terraces by these boys as practice work, under the supervision of the vocational instructor. Some training in terracing will be required of all senior agricultural students of the A. & M. College of Texas beginning next year. Terracing has become so general that people expect an agricultural graduate of the college to know how to do the work.

In Texas we have several educational agents of the commercial fertilizer companies who have backed us solidly in advocating terracing of land that is to have commercial fertilizers placed on it. We have several railroad agricultural agents who help us on the terracing program whenever the opportunity is presented.

It is needless to say that in no one place have all the above-mentioned influences been brought to bear. Some two or three of these factors have been applied in one place and a few of them in other places.

As to the future, we propose to continue the use of many of the features mentioned and hope to bring in some new influences. I believe that, if all agencies that lend money on land or agricultural production could be influenced to adopt a long-sighted policy they would join actively in the terracing program. I believe that loan agencies could get a lot of the land terraced before they have to take it, and if not before they get it, they could terrace it after they get it and before they attempt to dispose of it.

Another thing that might help the terracing program is some plan of financing the building of terraces with deferred payments. We dig drainage ditches and build levees by bond issues for the protection of agricultural land that is not deteriorating. It occurs to me that it is more important that some similar financing plan be worked out for the protection of land that is rapidly deteriorating.

In this state we also need better cooperation between our highway departments and farmers in the control of gullies, that start from the road drainage ditches.

I think that in some of our soils more efficient machinery is needed for the construction of terraces. In the black land belt of the state it is difficult to build terraces if the soil is at all wet. There should be some kind of a

machine that would move this dirt at any time, more economically.

In conclusion, the value of any campaign to promote terracing must be measured by the net results in terraces actually built in the fields. A real service may be rendered in utilizing the enthusiasm, and directing the offers of assistance, of those not directly engaged in farming to the end that soil conservation may be effected on the farms.

Those who are promoting terracing should be inspired by the thought that no matter what agricultural changes may come about, this work is fundamental and sound, and will never appear as wasted effort. No changes in the values of farm crops, in farm management, or in land utilization, can considerably change the value of terraces on the land.

Promoting Terracing in Oklahoma[1]

By G. E. Martin[2]

As IN Texas, the chief promotional agency of the Oklahoma extension service is the permanent demonstration. The permanent demonstration in terracing entails considerable cooperation. Upon the quality of the cooperation depends the final success of the demonstration. The quality of the cooperation is partly dependent upon the effectiveness of the selling agency and more largely upon many other human factors. The last few years has seen a great improvement in the quality of the cooperation available to the terracing movement, but it is still one of the big problems of erosion control.

In Oklahoma we have made no estimates as to the time period necessary to complete the job. Until the standards of the quality of cooperation are raised to the point where landowners will be satisfied with nothing less than a really effective job, we shall be unable to make a close estimate of the time required.

I am quite safe in saying that Oklahoma is not all terraced.

It seems hardly possible that promotional work in terracing can be overdone, yet some efforts of promoting the work need careful watching. In most instances, terracing is slow, laborious work requiring some degree of skill. Hip, hip, hurrah! methods will not be really effective in terracing. The magnitude of the job of erosion control in Oklahoma has led to the conclusion that terracing must become with us a commonly accepted good farming practice and we are proceeding along educational lines. Mr. Bentley's mention of the influence of money lending agencies, of some plan for financing terrace construction, also of the need for better cooperation between highway departments and farmers in caring for runoff water, should in my opinion be given careful thought by those concerned with future developments. These influences are promotional in that they seek a better understanding of the problem and closer cooperation between existing agencies.

[1]Discussion of paper by M. R. Bentley on "Promoting Terracing in Texas," presented at the 23rd annual meeting of the American Society of Agricultural Engineers, at Dallas, Texas, June, 1929

[2]Agricultural engineering specialist, Oklahoma A. & M. College. Assoc. Mem. A.S.A.E.

I would like to present the plan of one of our counties for promoting terracing.

Payne County encourages the private ownership of farm levels and rods. The county in 1927 purchased and placed twelve level outfits under the control of the county agent for farmers' use. The applicant for the use of an outfit first satisfies the agent as to his ability with the instrument, deposits ten dollars for its safe keeping; fair wear and tear excepted, furnishes considerable information useful for county agent annual reports, including number of days he proposes to keep the level, which is all card indexed. The agent makes it his business to call by and watch the progress of each worker. It frequently happens that all twelve levels are in use at one time and the agent is busy keeping up with them. If the applicant cannot satisfy the agent as to his ability, a demonstration or school of instruction is arranged.

The official measuring stick of our progress is the statistical part of our annual report to the U. S. Department of Agriculture. We have felt for some time that this did not disclose a clear perspective of our terracing effort. It asks two questions regarding terracing which we last year supplemented with others. The two questions referred to are:

1. Give number of farms constructing terraces or soil dams this year.
2. Acres on which soil erosion was so prevented.

Now a soil dam is not a terrace, nor does a terrace necessarily act as a soil dam.

From our supplementary sheet of questions we learned that 1949 adults were partly trained in terracing work; of this number 419 were competently trained. There were 1362 juniors partly trained and 317 completely trained. There were 847 adults in 1928 who terraced 18,338 acres on their own farms and 26,599 acres for neighbors. There were 393 juniors who terraced 4,046 home farm acres and 13,004 acres for neighbors. The number of farm levels in the state increased in 1928 from 512 to 782. We gained many other useful items of information which when analyzed helped us to guide and direct our own efforts as well as the efforts of others. We believe that community action in terracing is a possible future development.

(Left) An eroded alluvial plain in New Mexico. The regional uplands have been severely overgrazed and eroded. (Right) Excellent grass land being destroyed by erosion that had its beginning in a cattle bedding ground. The scene is in the Trans-Pecos region of west Texas

Studies of the Septic Tank Method of Sewage Disposal for Isolated Homes

By H. B. Walker[1] and R. H. Driftmier[2]

Apparatus. A Stephens water level recorder was used to record the fluctuation of the water level in the dosing chamber. This fluctuation of the water level in the dosing chamber is caused by (1) the flow of sewage from the septic chamber into the dosing chamber, and (2) the automatic discharge of this effluent by the operation of the siphon. The water level recorder (Fig. 6) was installed as shown in Fig. 7. The float is located in the dosing chamber. The rise and fall of the sewage are recorded on the cylinder chart by a pencil, which receives its vertical motion (one-half actual) due to the stage of the water in the tank. The horizontal motion is also recorded on the cylinder chart. The cylinder is actuated by an eight-day clock located within the cylinder. The record charts are changed each week. Fig. 8 shows a typical flow record for one week. The straight vertical lines are caused by the automatic discharge of the siphon.

The apparatus designated as "B" in Fig. 9 was used to measure the scum thickness. This device is so constructed that after the cutting blade has been pushed down through the scum, by lowering the rod "r", the blade will be turned at right angles to the handle. The device may them be lifted until the blade touches the bottom of the scum. The thickness is then read directly on the graduated handle.

Samples for chemical analysis were taken in one-half gallon Mason fruit jars by means of the apparatus designated as "A" in Fig. 9. This device has three metal fingers which hold the jar. The cover plate is held tightly in place to prevent the container from filling before it has been lowered to the desired depth. A ¼-inch pipe (not shown) was extended down along the handle and through the cover plate to exhaust the air from the jar as it filled. This was found to be necessary; otherwise, as the jar filled, the exhausted air would agitate the sewage to such an extent that representatives samples could not be secured.

Apparatus "C" (Fig. 9) was used for collecting bacterial samples. The small glass jars with glass stoppers were lowered by this device into the sewage. The rod, holding the glass stopper by means of the wood fingers, could then be raised until the stopper was partially removed from the jar. In this way only sewage came in contact with the inside of the previously sterilized jar.

Sewage and atmospheric temperatures were recorded by means of a Bristol recording thermometer. The thermometer mechanism was mounted in the shelter house used to protect the water level recorder. One bulb of the thermometer was placed at a depth of 2 feet in the sewage of the septic chamber; the other bulb was attached under the cornice of the shelter house where it would be protected from the direct rays of the sun and the prevailing winds. The thermometer tubes and bulbs were nickel plated to retard corrosion.

A special wooden cover was placed over the tanks instead of the concrete slabs ordinarily used. This cover, being much lighter, facilitated the investigational work. It consisted of two thicknesses of matched lumber separatd by roofing paper. This construction has approximately the same heat conductivity as 4 inches of concrete overlaid with 12 inches of earth, so that conditions approaching the usual farm installation in this latitude were obtained.

Rate of Flow. Flow records for the Agronomy Farm installation cover the period from June 1, 1923, to June 1, 1924; whereas those for the Poultry Farm installation cover the period from August 30, 1926, to March 19, 1928.

The largest weekly flow for the Poultry Farm installation occurred from June 27 to July 4, when six people occupied the house. The total flow for this week was 1430 gallons, or 34 gallons per person per day. The greatest weekly flow for the Agronomy Farm system occurred during the week of July 9-15. The total flow for this week was 2255 gallons, with ten people in the home, or 32.2 gallons per person per day. The minimum weekly flow of sewage from the Poultry Farm household was 600 gallons for the week of October 4-10, which, for the eight people served, gave a rate of flow of 10.7 gallons per person per day. The smallest weekly flow for the Agronomy Farm occurred November 19-25. The total flow for this week was 565 gallons, which, for the nine people, gave a rate of flow of 8.95 gallons per person per day.

Assuming that the standards of living in the two homes were comparable, it would seem then that the maximum

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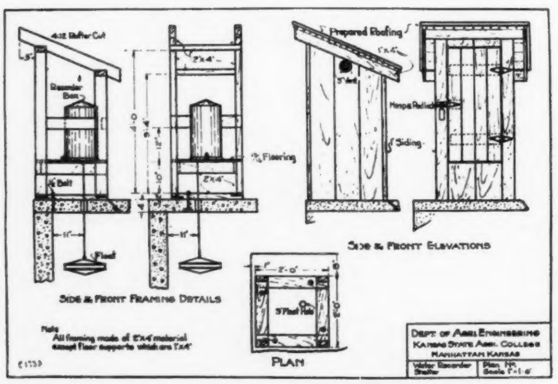


Fig. 7. This shows the details of the set-up of the water stage recorder

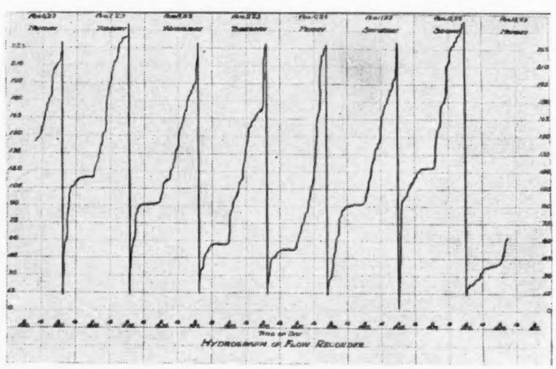


Fig. 8. A hydrograph of the water flow recorder

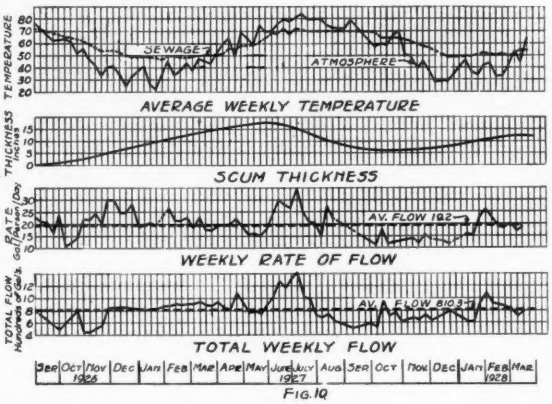
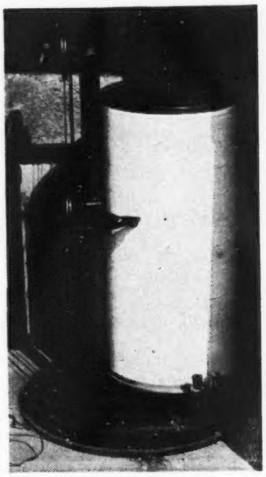


Fig. 10. These curves show records of temperature, scum thickness, rate of flow and weekly flow of sewage for the Poultry Farm installation



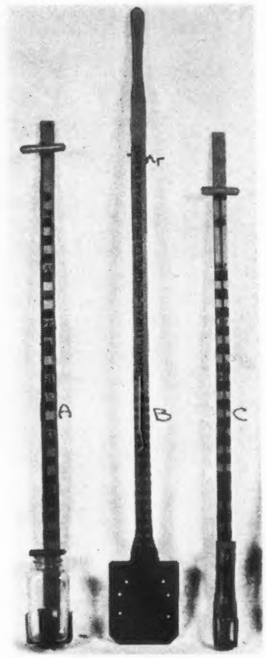


Fig. 6. (Above) Stevens water level recorder used to measure sewage flow in the Kansas sewage disposal studies
Fig. 9 (Right) This apparatus was used to secure chemical and bacterial samples of sewage

rate of flow might be expected during the season of highest temperatures (Fig. 10). However, the minimum rate of flow is apparently influenced by factors other than atmospheric temperatures. (Fig. 10).

It will be noted that the minimum and maximum rates of flow, expressed in gallons per person per day, are quite comparable. Fig. 11 shows the summarized flow records for both installations. The greatest daily flow average of the period observed for the Poultry Farm was 21 gallons per person per day on Monday, and for the Agronomy Farm 16.8 gallons per person per day on Saturday. It will be noted from Fig. 11 that the average monthly rate of flow for the Agronomy Farm installation started with a minimum of 9.5, gallons per person per day for Januray, rose with marked regularity to a maximum of 20.6 gallons per person per day for June, and then gradually decreased to 10.8 gallons per person per day for December, the average for the period being 14.5. This change did not occur with such marked regularity for the Poultry Farm installation.

Temperature. Temperature records on the Poultry Farm plant are shown in Fig. 10. It will be observed that the sewage temperature followed the atmospheric temperatures fairly closely, although abrupt changes in sewage temperature did not occur after extreme atmospheric temperature changes occurring within a short period of time. The sewage temperature varied from 48 degrees (Fahrenheit) as a minimum to 73 degrees as a maximum, with an average of 58.9 degrees.

Scum and Sludges. The thickness of the scum formation is shown graphically in Fig. 10. The scum thickness varied after formation had started, from about 6 inches to

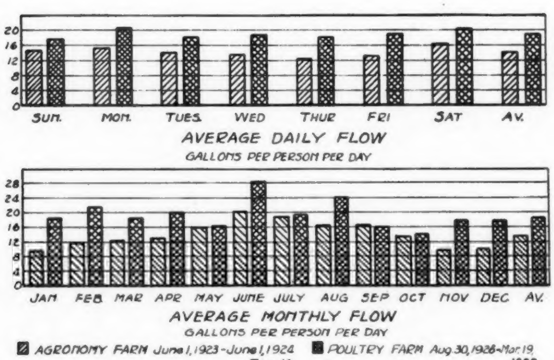


Fig. 11. The summarized flow records of both the Agronomy Farm and Poultry Farm installations

a maximum of 18 inches, with an average thickness of 10.3 inches for the period under observation. The graph indicating the thickness variation follows to some extent the sewage temperature curve. With the higher temperatures of early summer, a maximum thickness of scum occurs, and as the atmospheric and sewage temperatures decrease, the scum thickness decreases. The percentage of solids present in the sewage seems to have a bearing on the scum formation as indicated by the curves in Figs. 10 and 12.

This condition appears reasonable since the quantity of scum formed depends upon the character of the solids. There is a lag in the sewage temperature with reference to the atmospheric temperature in the fall of the year. The sewage temperatures remain fairly high during the fore part of the fall and winter, but finally the gradually decreasing temperatures become low enough to hinder bacterial action, thus causing the sludge to increase in thickness during the winter months. With the warming up of the weather in the early spring, bacterial action is accelerated, causing gases to be formed in the sludge. The gas bubbles evolved become impinged to fragments of the sludge and lift these to the surface, forming a scum. This scum will increase in thickness with the increased bacterial action. However, as the higher temperatures of the summer months continue, decomposition of the scum apparently takes place due to the continued bacterial activity brought about by favorable temperatures. This increase in thickness has an apparent "relationship" to the temperature curve of the sewage, which holds fairly well up to the point of maximum sewage temperature, after which the scum curve recedes at a much more rapid rate than the sewage temperature curve.

Chemical analyses of the scum and sludge accumulations are given in Table I. The scum thickness for the first sample was about 10 inches and for the second sample about 12 inches. The sludge accumulation at the time the sample was taken in April 1928, twenty-one months after the tank was placed in operation, was 9 inches. The analysis of the two scum samples are quite comparable. It is interesting to note, however, that the sludge differs from the scum in four main points. The scum contained

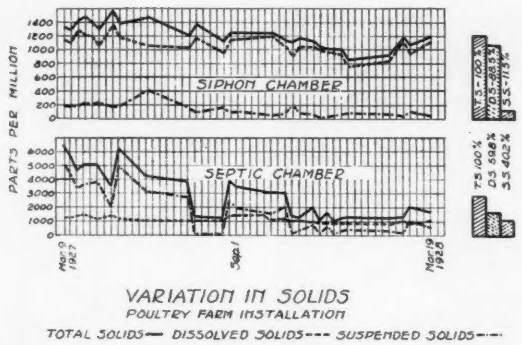


FIG 12

Fig. 12. Curves showing variation in solids of sewage on the Poultry Farm installation

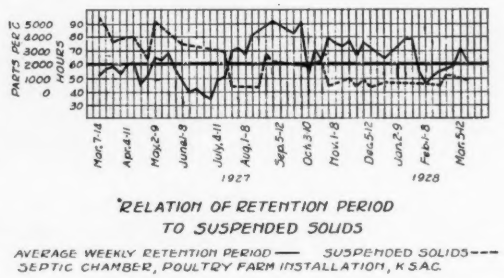


FIG 13

Fig. 13. Curves showing relation of retention period to suspended solids

almost twice as much nitrogen as protein as the sludge, from two to three times as much fat, from two to three times as much sugar, starches, etc., and only one-half as much ash. The fact that considerable gassing was always present in the tank, and whenever the scum was broken or the sludge disturbed, gassing was more noticeable than when the sewage was in a more or less quiescent state, indicates that the organic matter in the sludge was undergoing changes that would result in a reduction in its quantity. This is borne out by Table I, wherein it will be noted that the organic matter as represented by the fat, fiber, sugars and starches, is considerably less for the sludge than for the scum.

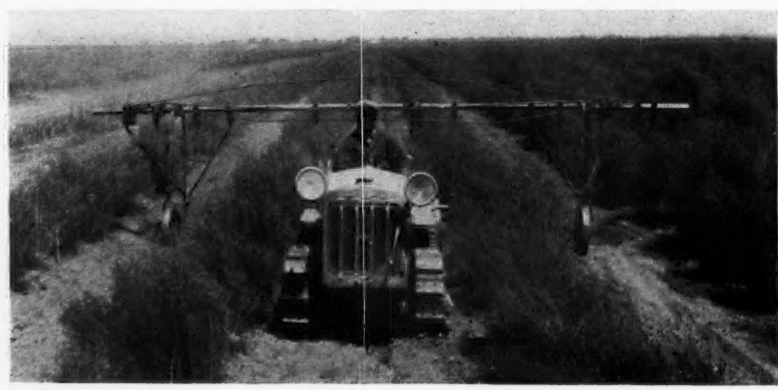
Further evidence of the gassing of the sludge is indicated by the following incident. The scum and sludge samples were placed in one-half-gallon Mason jars, the jars were sealed, and the samples were transmitted to the chemical laboratories for analysis. It was necessary to allow the samples to remain over until the following day. During the night the sludge jar exploded. Evidently the sludge digestion was proceeding satisfactorily, since, according to Metcalf and Eddy, "When sludge digestion is proceeding satisfactorily, the sludge when drawn from the tank will contain large quantities of gas held mechanically in it." This sludge was dark in color, somewhat granular, and did not have an offensive odor.

Retention Period. The average weekly retention period for the sewage in the septic chamber of the Poultry Farm system is shown in Fig. 13. The retention period for the months included on this curve varied from a maximum of 92 hours to a minimum of 35 hours, with 60 hours as the average for the period. The suspended solids in the septic chamber are shown by the dotted line. The straight horizontal line represents the average suspended solids and the average retention time for the period represented by the curves. It will be noted that from March to the middle of July the retention period was generally below the average, and the suspended solids were above the average. From July until March the opposite condition existed. This seems to indicate that the greatest reduction in solids to dissolved solids occurred when the retention period was over 60 hours. Since the temperature for this period (July to March) shows a general downward trend and since it is generally conceded that best bacterial action occurs at about 70 degrees, the principal reason for the decrease in suspended solids is evidently an increased retention period. These data indicate that the retention period for the settling chamber should be over 60 hours and below 80 hours, since a variation on either side generally resulted in an increase in suspended solids.

TABLE 1. Scum and Sludge Analysis
Poultry Farm Installation

	Scum 1-25-27	Scum 4-9-28	Sludge 4-14-28
Net weight received	*1090 grs.	**1809 grs.	**2028 grs.
Net weight dry	628 grs.	338 grs.	328 grs.
Per cent dry matter	56.6	18.68	16.17
Per cent water	42.2	81.32	83.33
Nitrogen as protein	15.90%	15.94%	8.25%
Fat	9.41	6.37	3.90
Fiber	5.64	6.42	6.16
Moisture	2.68	1.47	1.58
Ash	34.89	49.57	89.47
Nitrogen Free Extract			
Sugar, starch, etc.	31.48	20.23	10.53
Nitrates	None	None	None
Nitrites	None	None	None

*Air dry sample
**Sample as taken from tank



EDITOR'S NOTE: This is the second of three installments of this paper. The third will appear in the October issue.

An interesting application of mechanical - power equipment: Weeding the great asparagus fields of the California Packing Corporation near Rio Vista. The "Caterpillar" Ten is hauling a "Moline" Uni-Tiller; the latter was rebuilt for this job so as to handle three rows at a time. A large V-shaped knife does the work of weeding. This outfit, with the tractor running in second gear, covers seven acres an hour

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Load Test of Large Model of Cellular Concrete Arch. R. J. Fogg (Engineering News Record (New York), 102 (1929), No. 11-, pp. 418, 419, figs. 2).—Tests conducted at Lehigh University of a box section hollow rib under two-point loading between rigid abutments are reported.

The results showed that the arch ring carried nearly sixty times its own weight under very unfavorable loading. The failure was caused by a heavy concentration on the thin model, coupled with heavy radial shears produced just outside of the loading points. These heavy local stresses and excessive radial shears would not occur on a full-size arch, especially where loading is applied at intervals along the arch instead of at two points only.

The computed compressive stresses were in all cases higher than those indicateed by the extensometer measurements. Under 180,000 pounds the compression ranged from 1,000 to 1,700 pounds, per square inch near the crown and from 1,100 to 1,900 pounds per square inch in the haunches. The maximum web stress due to shear, just before the first sign of crack at the 180,000 pounds loading, was estimated to be about 500 pounds per square inch. The deflection at the crown under the same loading was ¼ inch.

Winter Temperature of the Floors of Dairy Barns (Kansas Station (Manhattan) Biennial Report 1927-28, pp. 96, 97).—A study of winter temperatures of the floors of dairy barns as influenced by different materials showed that solid concrete floors compare favorably with floors constructed of building tile between two layers of concrete. The layer of concrete over the building tile conducts heat away from the cow as rapidly as the solid floor. The 2-inch plank floor warmed up more rapidly than the concrete, the rate being three to four times as fast. This was probably due to the difference in conductivity of the two materials. Cork brick or creosoted pine block maintained about the same temperature as the plank floor. The temperature on the creosoted pine block floor compared very favorably with that on the cork brick floor. This is important because of the difference in initial cost and the comparative wearing qualities of the two floors

Air Permeability of Building Materials and Building Construction Parts [trans. title], E. Raisch (Gandhts Ingen., 51 (1928), No. 30, pp. 481-489, figs. 10).—In a contribution from the Technical Academy of Munich the results of tests are reported made to determine the air permeability of different building materials, walls and types of construction. From these results certain mathematical expressions for air permeability are deduced.

The results show that from the ventilation standpoint the air renewal through walls and other building parts is inadequate. This is especially true with reference to plastered walls. On the other hand, it was found that the air movement through walls and especially through and around doors and windows should be of particular concern from the heating standpoint.

With brick walls it was found that the greatest passage of air takes place through the mortar band. The passage of air through a single brick was in no manner representative of the passage through a brick wall, especially where a mortar band was used.

Plaster coatings on brick walls were found to have a much lower permeability than the wall itself. The resistance of the plaster to air penetration was increased by whitewashing. The resistance of plastered wood walls to air penetration compared well with that of plastered brick walls. Results are also reported for unplastered wood walls, doors and windows.

The Pressures Under Substructures, J. H. Griffith (Engineer and Contractor (Chicago) 68 (1929), No. 3, pp. 113-119, figs. 4).—In a contribution from Iowa State College a simple dynamical formulation of the laws of pressure distribution independently of molecular hypotheses of matter is presented. The proposed method, while specialized in the present case, is completely generalized so as to apply to earth resistance problems of every nature.

Fire Resistant Construction, R. E. Stradling and F. L. Brady ([Great Britain] Department of Scientific and Industrial Research (London) Building Research Special Report 8 (1927), pp. VI+57, pls. 2, figs. 27).—Part 1 of this report presents a brief outline of the effect of high temperatures upon building materials generally.

Part 2 reports experiments to elucidate and to improve the fire resisting properties of concrete It is shown that by the addition of a pozzolanic material to portland cement concrete a very considerable absorption of the lime set free on hydration of the cement, can be brought about, the presence of this free lime being demonstrated to be the most serious factor in the deterioration of concrete under fire.

The conclusion was drawn that fire resistant cement may be made by the addition of various substances to the cement, the most suitable of these being certain varieties of clinker and baked clay. Spent shale was found to be a promising material and granulated slag also gave excellent results.

It was found that the special cement can be used in conjunction with fine aggregates such as red brick and dolerite of different kinds.

Three appendixes on a method for determining free lime in portland and special cements, the suitability of furnace clinker as an addition to portland cement, and high aluminous cements are included, together with a bibliography.

Utilization of Electric Equipment on the Farm, F. J. Zink and F. D. Paine (Iowa Agricultural College (Ames) Official Publication, 27 (1928), No 10, pp. 53, figs. 17).—This report on the Iowa project on rural electrification contains information and suggestions useful to farm operators and others interested in the problems connected with the use of electricity on the farm. A general summary is attached relating to the kinds of electrical equipment on eleven farms at Garner, Iowa. Lighting is considered by the farmers to be the most important use of electricity on the farm. The electric farm motor is recognized as being more desirable than either the small stationary engine or the windmill.

[Irrigation and Drainage Investigations at the Utah Station] (Utah Station (Logan) Bulletin 209 (1929), pp. 70-74).—The progress results of studies of irrigation pumping and of flood and gravel control, by L. M. Winsor, and the relation of stream discharge to precipitation, by G. D. Clyde, are briefly reported.

In the last study it was found that the density of snow increases up to a maximum when melting begins and decreases after melting begins. The maximum is different for different years, depending quite largely upon temperature and soil moisture conditions. There is a very definite lag in time from when snow starts to melt and water appears as run-off. This lag is dependent upon temperature and moisture in soil when melting begins.

Sufficient water from snow must go into the soil to saturate it before run-off begins. Fall precipitation and the physical condition of the surface soil determine quite largely the character and extent of run-off.

The studies to date indicate a very close correlation between the snow cover on the Logan drainage and the run-off of the Logan River for the period April to September, inclusive. By measuring the snow cover at Franklin Basin, Tony Grove and Mount Logan along the fore part of April it is possible to predict within 10 per cent what the seasonal run-off will be.

Book Review

"Wood Floors" is a new booklet for home owners and builders. The qualities and characteristics of various types of wood floors, when and how to lay floors, construction details, grades and sizes of flooring, wood floors on concrete, porch floors, finishing and resurfacing old floors are covered in thirty 8½x11-inch pages, with illustrations of plain and fancy wood floors. Single copies of the booklet will be sent free to anyone on request to the National Lumber Manufacturers Association, 702 Transportation Building, Washington, D. C.

"Irrigation Districts in California," by Frank Adams, is a paper bound book of more than 400 pages, published as California Department of Public Works Bulletin No. 21. It takes up the history, organization, and legislation of such districts in general, and gives specific data on each of the many active, partically active and inactive districts in the state. Illustrations, tabular matter, conclusions and an index are included.

AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

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RAYMOND OLNEY, Editor

R. A. Palmer, Assistant Editor

Basic Training

THE field of agricultural engineering is relatively new and has come to public attention recently because of the economic situation in the agricultural industry. Industries serving agriculture such as public utilities, implement manufacturers and building material companies have recognized the need of engineers who are able to analyze the engineering problems of the agricultural industry. These concerns have drawn heavily upon the available agricultural engineering talent, particularly the more mature men, with the result that our educational institutions have had some difficulty in securing satisfactory personnel. The field of agricultural engineering is now well established and some expansion in the training of men for this professional service might be profitably encouraged.

The training of men for such fields does not require very much specialized instruction but it does require a combination of scientific knowledge somewhat different from the usual engineering curriculum. It must be just as fundamentally engineering as in other fields but the emphasis of these fundamental applications must be directed toward the problems of the agricultural industry. To comprehend these properly the engineer must be trained to work with other scientists in problems of agricultural production and processing in which the biological sciences are basic.

The agricultural engineer of necessity must have some basic training in the agricultural sciences. He must recognize the opportunities for the application of the physical sciences as well as their limitations. He must appreciate the tremendous importance of the biological sciences to the agricultural industry, and his efforts should be directed toward the expansion of their usefulness by coordinating with these the applications of the physical sciences. In all of these matters the agricultural engineer must remain essentially an engineer.

So far as direction of work is concerned this does not seem important so long as proper men are developed by adequate fundamental training. In general, the agricultural executives in higher education are more alert to the importance of this field than similar executives in engineering. A more sympathetic and aggressive interest among the latter is desirable. That this is developing is evidenced by the recent appointment of an agricultural engineering committee by the Society for the Promotion of Engineering Education. Just now between 250 and 300 students are receiving professional agricultural engineering instruction in a dozen or more land grant colleges and universities.

The thought that major instructors in professional courses should be faculty members in both agriculture and engineering merits careful consideration. Certainly the engineering preparation of undergraduates and graduates should meet the approval of engineering colleges, and the agricultural preparation should likewise be scrutinized by the colleges of agriculture.

In this as well as in other new professional courses it is difficult to attract the right type of undergraduate. Often times such courses attract the curious who lack real objectives in preparation for life work. Furthermore, agriculture in the past has lacked a professional appeal. Rurally minded students succeed best in agricultural engineering, and to attract the best of these is more difficult than to attract the better talent from metropolitan areas.

H. B. Walker.

Soil Erosion

EROSION is gradually dawning upon the agricultural consciousness of America as one of its major problems.

Like a mighty octopus a gully will reach out its tentacles and swallow whole farms with insatiable appetite. Less ostentatious, leech-like, sheet erosion sucks the lifeblood of agriculture—the top six inches of soil. So insidious is its attack that its importance seems to have been discovered only recently by students of erosion. Many a farm has washed and is washing out from under the owner's feet without his being aware of it. Papers published in this issue show erosion to be a world problem. Few soils are immune or even highly resistant to it; cultivation stimulates it; even slight slopes encourage it.

We might have learned to appreciate and guard against the depredations of erosion from the history of former civilizations. The fact that we have not exemplifies adages to the effect that experience keeps a dear school, and that a student for it is born every minute.

Erosion is farm relief with a vengeance. It is rapidly reducing the surplus production capacity of American agriculture. But while it is throwing marginal farms hopelessly below the margin, it is likewise taking its toll from good farms; and when agriculture needs more production capacity it will not be able to bring back the soil and plant food which is now slipping away to the sea.

If the chief capital of its agriculture is only six inches thick and is being washed away more than twenty times as fast as it can be renewed by nature, how long will it take America to wake up and do something about it? Any institution or individual guilty of such gross neglect in the handling of other forms of public trust would be prosecuted. But soil erosion is allowed to continue as if it were strictly a personal matter to each individual landowner.

If a great fire were sweeping the country, doing damage at the rate it is being done by erosion, an army of fighters would be mustered to combat it. But for soil erosion a few scattered sentinels are posted to observe the destruction and give the alarm before it comes too close to home.

These sentinels—soil scientists, agricultural engineers and a few others who have been on the watch—have seen this terrible blight sweeping over the country, fed by farms that man can never rebuild. They know a way of stopping it. It is time to broadcast the alarm in no uncertain terms.

The fact that the principal means of combat, terracing, is an engineering one, places squarely before agricultural engineers the responsibility for leadership in the fight against soil erosion.

Who's Who in Agricultural Engineering


W. W. McLaughlin


L. J. Smith


M. M. Jones


A. W. Farrall

W. W. McLaughlin

Walter Wesley McLaughlin (Mem. A.S.A.E.)—a past-chairman of the A.S.A.E. Pacific Coast Section—is associate chief of the division of agricultural engineering, U. S. Department of Agriculture, in charge of the western headquarters of the division at Berkeley, California. After receiving his bachelor's degree in civil engineering at Utah Agricultural College in 1896, he entered private practice as a mining engineer, which he followed until 1904, when he became assistant irrigation engineer at Utah Agricultural Experiment Station. In 1903 he also was appointed irrigation aid in the U. S. Reclamation Service. The following year his government connection was transferred to the U. S. Department of Agriculture, in what later became the division of agricultural engineering. In 1910 he did some graduate work in irrigation at the University of California. In addition to his government and state connections from 1903 to 1914, during which time he advanced to the position of irrigation engineer, he also carried on some private investigations. During the latter year he severed his connection with Utah and went to California to give all of his time to the U.S.D.A. irrigation investigations. Appointment to his present position came in 1925.

L. J. Smith

Leslie John Smith (Mem. A.S.A.E.) is professor and head of the department of agricultural engineering at the State College of Washington, coming to Washington in 1921 from Manitoba where for eleven years he was professor of agricultural engineering at Manitoba Agricultural College at Winnipeg. He graduated at Michigan State College in 1906 in mechanical engineering and secured his professional degree in mechanical engineering from the same institution. While a senior he assisted in the farm short course work, and upon graduation was asked to remain and develop the department of farm mechanics. While at Winnipeg he was actively connected with the farm tractor competitions which were held annually in connection with the Winnipeg Industrial Exposition. Since the inauguration or rural electric studies he has been secretary of the Washington Committee on the Relation of Electricity to Agriculture. He is author or co-author of 15 bulletins pertaining to agricultural engineering and has also written a book entitled "Essentials in Mechanical Drawing." Recently he wrote material for bulletins for the West Coast Trade Extension Bureau. He has served on various committees of the Society.

M. M. Jones

Mack Marquis Jones (Mem. A.S.A.E.)—chairman of the A.S.A.E. North Central Section—is associate professor of agricultural engineering at the University of Missouri. Upon receiving his bachelor's degree in electrical engineering from the University of Illinois in 1918, he entered the army where his engineering training was applied to airplane motor and signal corps work. Leaving the army the following year he became an instructor in agricultural engineering at the A. & M. College of Texas; soon went to the University of Missouri in a similar capacity; has remained there since that time with the exception of a year (1926-27) which he spent in graduate work at Iowa State College; and has advanced to his present position, in charge of the farm power and machinery work of the department. He is also project leader of the Missouri Committee on the Relation of Electricity to Agriculture, and author of several experiment station bulletins and articles in technical and agricultural periodicals, including AGRICULTURAL ENGINEERING. Since affiliating with the Society in 1919 he has been active in its work to an extent which makes him well qualified for his present chairmanship.

A. W. Farrall

Arthur W. Farrall (Assoc. Mem. A.S.A.E.) is development engineer in charge of research for the Douthitt Engineering Company, which specializes in spray drying plants and creamery equipment. After receiving his bachelor's degree in agriculture in 1921 and his master's degree in 1922 at the University of Nebraska, he went to the University of California as assistant in the agricultural engineering and the dairy industry divisions. When he resigned at the end of 1928 to accept his present position, he was assistant professor of agricultural engineering. He has shown a great deal of leadership in developing dairy engineering as a branch of agricultural engineering and of the activities of the Society. Since going to California in 1922 he has developed a course in dairy machinery at the University of California; done a great deal of investigational work on sterilizers, refrigerating machinery, solar heaters and other dairy equipment; written many articles and chapters of books on dairy engineering subjects; initiated (1927) and has served as chairman of the Dairy Engineering Committee of the Society since that time, and in this capacity, with the cooperation of the Pacific Coast Section and of the Pacific Slope Dairy Exposition, held the first technical meeting of dairy engineers.

A. S. A. E. and Related Activities

Advisory Council of Structures Research Meets

THE first meeting of the Advisory Council of the Structures Research Survey, appointed by Hon. Arthur M. Hyde, Secretary of Agriculture, to function with Henry Giese, director, was held in Washington, August 27. The personnel of the Council consists of representatives of various organizations directly interested in the development of farm structures. The membership includes: (1) Henry Giese, senior agricultural engineer, U. S. Department of Agriculture, director; (2) American Farm Bureau Federation (representative not designated); (3) American Society of Agricultural Engineers, represented by W. G. Kaiser, president, and J. L. Strahan, chairman, Structures Division; alternate, F. C. Fenton, vice-chairman, Structures Division; (4) Common Brick Manufacturers Association of America, represented by L. B. Lent, chief engineer; alternate, J. W. McBurney, research associate, U. S. Bureau of Standards; (5) Farmers' Education and Cooperative Union of America, represented by W. P. Lambertson, vice-president, Kansas Farmers' Union; (6) National Association of Farm Equipment Manufacturers, represented by J. L. Strahan, agricultural engineer, Louden Machinery Company; (7) National Grange, represented by Mrs. Margaret Robinson; (8) National Lumber Manufacturers Association, represented by Frank P. Cartwright, chief engineer; (9) Portland Cement Association, represented by W. G. Kaiser, agricultural engineer; alternate, E. G. Lantz, assistant manager, cement products bureau; (10) Sheet Steel Trade Extension Committee of the National Association of Flat Rolled Steel Manufacturers, represented by Stanley A. Knisely, director of research; (11) Structural Clay Tile Association, represented by E. C. Kerth, secretary; and (12) U. S. Department of Agriculture, represented by Thomas H. MacDonald, chief, Bureau of Public Roads; Dr. E. W. Allen, chief, Office of Experiment Stations: Dr. Louise Stanley, chief, Bureau of Home Economics, and S. H. McCrory, chief, division of agricultural engineering, Bureau of Public Roads.

In spite of the short notice the meeting was well attended, a gratifying indication of the interest which later developed in the discussions of the Council. Henry Giese, director of the survey, presented a tentative outline program of procedure to be followed in making the survey. After discussion leading to a few changes which were thought desirable as adding effectiveness, the program was approved.

Aside from the ratifying of the program the purpose of the meeting was to obtain the suggestions and advice of the Council members, particularly those representing the industries, as to ways and means of securing the desired cooperation between the industries and public research agencies, in carrying out a coordinated program of research investigations. The response of the Council members to this appeal for assistance was most gratifying and indicated a very general and sincere desire to aid in every possible way.

It was brought out that the industries are greatly handicapped by the lack of definite information as to fundamental requirements of farm structures. The variations in existing data, which are largely but accumulated opinion without scientific basis, are such that actual facts are difficult to obtain. The farm buildings recommended by the various state authorities vary so widely as to type that industries concerned are at a loss in meeting the requirements. If some measure of standardization could be brought about, at least within sections of the country subject to the same climatic and other farming conditions, the manufacturers' problems would be greatly simplified.

The mutual benefit to be derived from close cooperation between industries and colleges in research investigations was made clear. It was shown that, if the industries would cultivate acquaintance with college work and workers, exchange ideas, and submit their problems for solution, the result would be more college publications with authoritative data available to industry to be passed on through their own channels. The more research, the more publicity and consequently greater interest of farmers and other concerned with farm structures with profit to all.

The acceptance and dissemination, by the industries, of information received from the colleges would redound to the advantage of the latter, increasing their prestige and extending their usefulness.

The response of the Council members to the directors' appeal for advice and suggestions and the general enthusiasm evident throughout the discussions was a most auspicious start for a decidedly important undertaking.

Dairy Engineers' Day

"DAIRY Engineers's Day" will be an innovation of the National Dairy Industries Exposition at Toronto, Canada, this year. The Dairy Engineering Committee of the American Society of Agricultural Engineers is sponsoring a technical meeting of interest to dairy machinery men, manufacturers, salesmen and plant engineers. October 24 is the date set for the meeting.

Subjects on the program include "Looking to the Future of Dairy Engineering," "Application of Direct Expansion to Dairy Cooling," "Frozen Carbon Dioxide Applied to Dairy Refrigeration," "Modern Methods of Water Treatment," "Engineering Needs of the Modern Dairy Plant," "Training Dairy Engineers," "Properties of Dairy Products which should be Considered in the Design of Dairy Machinery," "Heat Transfer in Dairy Equipment," and "Automatic Control of Temperature in Dairy Equipment."

Members of the Dairy Engineering Committee of the American Society of Agricultural Engineers include A. W. Farrall, chairman, development engineer, Douthitt Engineering Co. (formerly in charge of dairy engineering at the University of California); H. C. Fielder, Cherry Burrell Corp.; R. L. Perry, University of California; O. F. Hunziker, Blue Valley Creamery Co.; J. T. Bowen, dairy department, U.S.D.A. This committee hopes this meeting may be followed by annual national meetings of dairy engineering. It also plans to send out monthly news letters on dairy engineering giving abstracts of valuable articles on subjects in current literature. It has pointed out that the dairy industry today is largely dependent on the use of machinery, and that the progress of the entire industry depends on progress in the further improvement of dairy machinery.

Personals of A.S.A.E. Members

Frank Adams, irrigation economist, University of California, and irrigation manager, U. S. Department of Agriculture, is author of Bulletin No. 21, entitled "Irrigation Districts in California," which consists of a series of reports of more than 400 pages recently issued by the division of engineering and irrigation of the department of public works of California. The material in the bulletin


New Departure
Equipped

was gathered under cooperative agreement between the division of engineering and irrigation, California Department of Public Works; division of irrigation investigations and practice, University of California Agricultural Experiment Station; and the division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture.

W. T. Ackerman, electrical project director and engineer, New England Rural Electrification Project, is author of Bulletin No. 244, entitled "Electric Household Refrigeration," just issued by the New Hampshire Agricultural Experiment Station.

R. U. Blasingame, head of the department of farm machinery, Pennsylvania State College, announces the appointment of John E. Nicholas as associate professor of farm machinery, in charge of rural electrification research. Mr. Nicholas is a graduate of Lehigh University in mechanical engineering, entering the employ of the Bethlehem Steel Company on graduation. Several years later he received his master's degree from the Massachusetts Institute of Technology, and for the past three years has been employed in the department of mechanical engineering of the University of Minnesota.

L. G. Heimpel, professor of agricultural engineering at Macdonald College, Quebec, is temporarily located at Cornell University, where he is doing work toward his master's degree in agricultural engineering.

H. B. Josephson, research engineer, department of farm machinery, Pennsylvania State College, is joint author with R. U. Blasingame, professor of farm machinery at the same institution, of Bulletin No. 238, entitled "Farm Power and Labor," recently issued by that institution. Mr. Josephson is also joint author with W. R. Humphreys and L. M. Church of Bulletin No. 237, entitled "A Farm Machinery Survey of Selected Districts in Pennsylvania," recently issued.

Archie A. Stone, head of the department of farm mechanics, State Institute of Applied Agriculture, Farmingdale, New York, is author of a bulletin entitled "Garden Tractors on Long Island," which has just recently been published.

New A.S.A.E. Members

Hardine L. Atkins, Jr., associate editor, "The Progressive Farmer," Dallas, Tex.

Durga N. Banwet, lecturer, The Maclagan Engineering College, Moghalpura, Lahore, Panjab, India.

John E. Dougherty, associate professor of poultry husbandry, University Farm, Davis, Calif.

Joseph E. Hooker, agricultural engineer, South Carolina Agricultural Extension Service, Columbia, S. C.

Hendrik de Leeuw, agricultural engineer, 14 West 90th St., New York, N. Y.

Franklin D. Lown, agricultural advisor, San Antonio Suburban Irrigated Farms, San Antonio, Tex.

Earl I. Myers, civil engineer, Clark E. Jacoby Engineering Co., Kansas City, Mo.

Leonard G. Schoenleber, junior engineer, U. S. Department of Agriculture, 615 Front St., Toledo, Ohio.

D. E. Wiant, instructor in agricultural engineering, South Dakota State College, Brookings, S. D

Transfer of Grade

George R. Louthan, experimental engineer, General Implement Co., Racine, Wis. (Student to Junior Member.)

Ralph A. Palmer, assistant secretary, American Society of Agricultural Engineers, St. Joseph, Mich. (Junior to Associate Member.)

Raymond J. Tillotson, rural service engineer, Kansas Gas & Electric Co., Newton, Kans. (Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the August issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

George L. Bell, general sales manager, Caterpillar Tractor Co., San Leandro, Calif.

Henry T. Burnam, agricultural engineer, El Paso Electric Co., El Paso, Tex.

Tudor J. Charles, Jr., research departments, National Association of Farm Equipment Manufacturers, Chicago, Ill.

Fred M. Chase, student apprentice, J. I. Case Co., Rockford, Ill.

C. T. Colley, The South Coast Co., Houma, La.

S. S. Conaway, sales promotion manager, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Ralph D. Cutler, vice-president, The Hartford Electric Light Co., Hartford, Conn.

Bruce H. Gallup, salesman, The E. A. Kaestner Co., Baltimore, Md.

Walter F. Kreiselmaier, farm manager, Fargo, N. D.

James R. McCalmont, electrician, A. M. Bayers Co., Ambridge, Pa.

Harold T. Murray, vice-president, "Electricity on the Farm," 30 N. Michigan Ave., Chicago, Ill.

Clarence R. O'Brion, district sales manager, Caterpillar Tractor Co., Moscow, U.S.S.R.

Arthur W. Reynolds, vice-president, The Babcock Mfg. Co., Leonardsville, N. Y.

Lloyd S. Schultz, rural service engineer, Pennsylvania Power & Light Co., Allentown, Pa.

Albert K. Short, conservation and terracing agent, Federal Land Bank of Houston, Houston, Texas.

C. T. Vassilieff, professor, Leningrad Agricultural Institute, Leningrad, U.S.S.R.

Russell B. Williams, editorial director, Reincke-Ellis Co., Chicago, Ill.

Employment Bulletin

Positions Open

AGRICULTURAL ENGINEER wanted as an instructor in mechanical drawing and drawing of farm buildings in one of the leading agricultural engineering departments of the north central states. For a good man with an agricultural engineering degree the salary will be $175 a month for nine months. PO-156.

AGRICULTURAL ENGINEER wanted to take charge of extension work in agricultural engineering at one of the agricultural colleges in the northwest. A man with good fundamental training in agricultural engineering preferred. Salary range from $2400 to $3000, depending on qualifications. PO-161.

FARM MANAGER to handle 3500-acre power farming project in Kansas on which wheat and roughage crops are grown. Man must be a mechanic to supervise operation and maintenance of tractors and other farm equipment. He should also be informed on best farming methods employed in western Kansas and should have sufficient clerical knowledge to keep data on operations performed. Should be of good character and capable of managing labor. Straight salary or salary and profit basis. PO-162.

Men Available

FARM MANAGER, agricultural college graduate, experience in lowcost production—organizing and handling farm labor, farm machinery, farm layout, stock raising and feeding, and soil building. Trustworthy, married. MA-165.